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Pointers on Electric Steel Furnace Practice

Practical Data on Arc-Type Furnaces Obtained from Research Work and Experience in Various Foundries—Technical Training an Advantage

By H E Diller

ALTHOUGH a comparatively new metallurgical instrument, the electric furnace has so clearly proved its worth for melting and refining steel that it is being rapidly adopted for many classes of work in foundries where fuel-melting processes were employed exclusively heretofore. When it was first tried out, its operation was comparatively expensive and it was felt that it could compete only with the crucible furnaces; not in cost of operation, but due to the fact a cheaper stock could be used. For this reason its use was confined at first almost entirely to the manufacture of tool steel in competition with that made by the crucible process, although it was some time before electric-furnace steel was able to establish itself as the equal of crucible steel in quality. This, however, is now generally acknowledged. Later, as the cost of operation was gradually reduced, due to many factors, the electric furnace became more widely used for melting and refining various metals. It has been adopted for refining steel made in the open-hearth furnace, for making alloy and carbon steel castings, for melting brass and gray iron, for refining malleable iron which has been melted in the cupola and for other duplexing processes.

Not only is the electric furnace adapted to a great variety of work, but there are many kinds of electric furnaces. Broadly speaking, for making steel there are two general types of furnaces in operation. One is the induction furnace in which the heat is developed by a current of electricity induced into a circular bath of the metal being refined, which thus becomes the secondary circuit of a transformer. The other type is the arc furnace in which the heat is obtained from one or more electric arcs. There are many varieties of such furnaces based on different patents. In this article we will consider arc-furnace practice from the standpoint of the work of three different foundries and the experience of the writer in research work. For the benefit of those not familiar with electric furnace practice, some elementary considerations will be presented in this article. Most arc furnaces can be worked with either an acid or a basic bottom. Acid bottoms are put in with sand. When steel is melted on such a bottom very

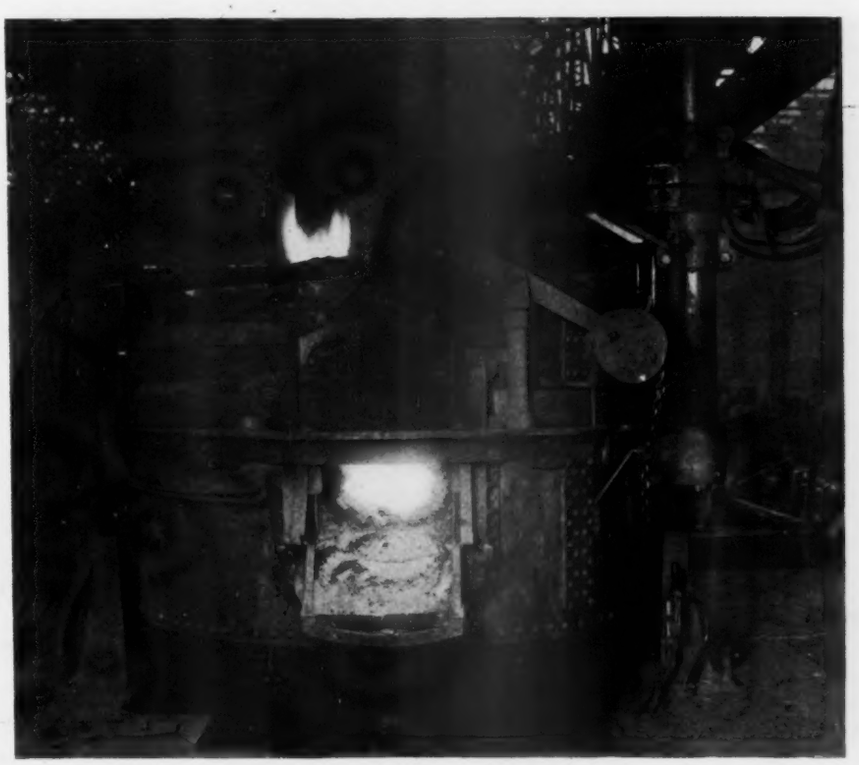


FIG. 1—MOORE ELECTRIC STEEL FURNACE

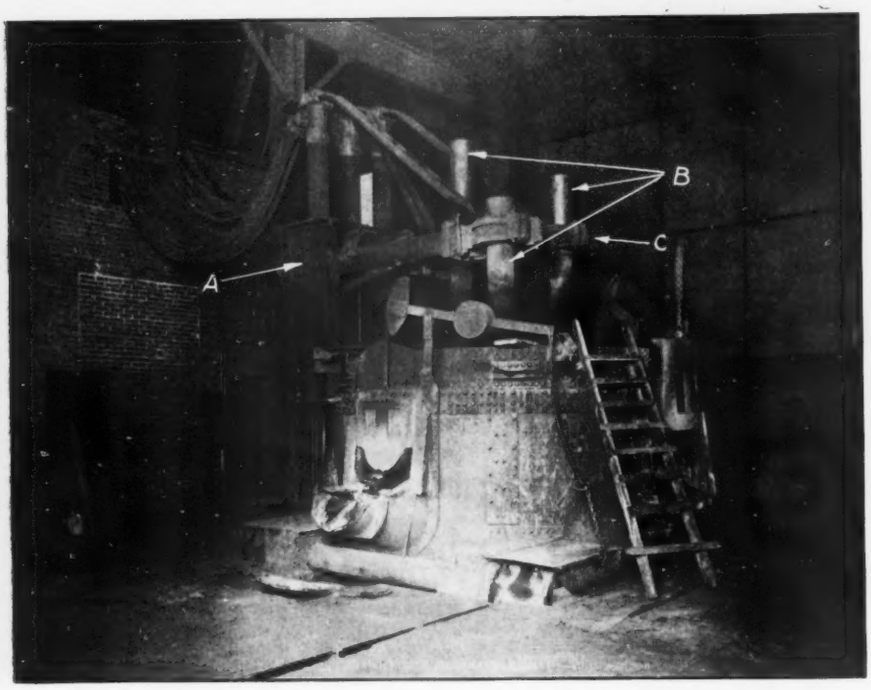


FIG. 2—15-TON HEROULT FURNACE AT NATIONAL MALLEABLE CASTINGS CO., CLEVELAND

little sulphur and phosphorous reduction takes place, the action being merely a melting-down process. This may be accomplished under the very best conditions as a reducing atmosphere can be kept in the furnace during the entire melt, if desired, thus preventing oxidation. But should it be necessary to oxidize the bath to bring down the carbon, it can be done and later the metal can be killed and held in the furnace a short time under a reducing atmosphere until freed of oxides.

The Technical Man's Chance

A furnace with a basic bottom affords an opportunity, starting with almost any kind of a charge, to take carbon out or add it, to reduce the sulphur considerably and the phosphorus to a trace, to take the manganese out or bring it up to any desired proportion by addition, and to add alloys to the bath with very little loss, finally pouring a perfectly quiet metal free from oxides. Such a furnace is as much a laboratory instrument on a large scale as it is a piece of shop equipment, and experience has shown that to get the most out of it, a technical man should be placed in direct charge of its operation. This can be more clearly appreciated when we consider that a knowledge of electricity is advantageous to the melter because the complicated automatic control, the moving parts and the arcs are all operated by electricity; while owing to the fact that the process is based on chemical reactions, a knowledge of chemistry is almost essential. Fortunately for the technical man, it is easier for him to acquire facility in handling electric than open-hearth furnaces. The reason for this is that knowledge of chemistry and physics is as valuable in dealing with electric furnaces as shop experience. Such is not the case with open-hearth furnaces. In the open-hearth the heat is obtained from a flame which must be judged by the eye as to whether it is oxidizing or reducing, too hot or not hot enough, and an inexperienced eye would soon burn down the furnace or not get the metal hot enough. In the electric furnace, on the other hand, the temperature is controlled by the quantity of electricity put into it; this can be easily regulated by the operation of a switch and the amount accurately determined by reading a meter. Therefore, there is little likelihood of a novice doing much damage to the furnace from over-heating, and he also can tell by a simple test whether the metal is not hot enough without depending on the judgment of the eye. This test consists of taking a spoonful of the steel, and with a stop-watch, determining the length of time it takes to set. Metal which remains liquid in the spoon for 25 seconds is hot enough to pour.

Using Up Machine Shop Scrap

With the electric furnace, turnings and scrap from the machine shop can be melted and refined into high-grade steel for castings. One heat a day can be taken off and the furnace allowed to cool without much damage to the lining; and when business is good, as many as eight heats can be taken off in a day, three hours having been found long enough to charge, melt, and pour a heat. But when it is necessary to take off the first slag, owing to having started with a high sulphur or high phosphorus stock, or to a desire to get a specially highly refined metal, 1 to 1½ hours more are required. Another advantage of the electric furnace is that an extremely hot metal can be obtained which can be poured into small sections or transferred from a crane ladle to hand ladles without danger of skulling. If a few special alloy steel castings are wanted they can be cast without making up a large charge.

The amount of electric power required to make a heat of steel is a rather indefinite quantity, as so many factors enter into the question. Each foundry naturally wishes to report as good a record as possible, but practically no foundry is operating continu-

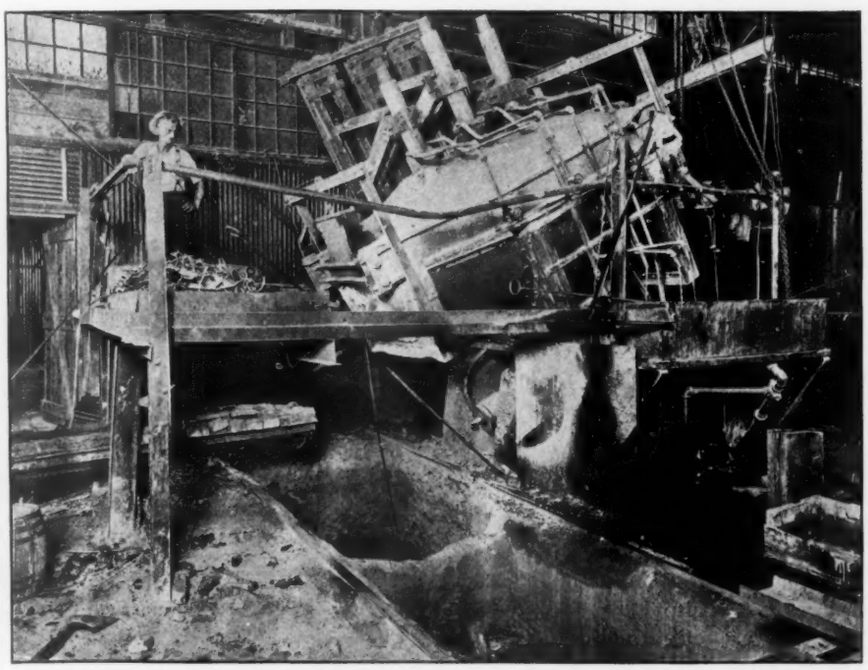


FIG. 3—LUDLUM FURNACE, FIVE TONS CAPACITY, OPERATED BY THE LUDLUM STEEL CO., WATERVLIET, N. Y.

ously, under which condition the best results are obtained. Therefore, the average electric furnace user does not like to say much about his power consumption. Starting from a cold furnace the first heat requires more power than subsequent heats, and if a second slag is made, this again increases the amount of power consumed. The best records which have been made on furnaces with which the writer is familiar, run a little over 500 kilowatt hours per ton of metal, while as high as 1000 kilowatt hours per ton have been consumed when starting with a cold furnace and highly refining the metal.

Tpyical Electric Furnace

A typical electric furnace is shown in Fig. 2. It consists simply of a steel shell mounted on a tilting device and provided with supports for holding the electrodes. The electrode holders are shown at *A*. They clamp the electrodes *B* with water-cooled rings *C* and are raised and lowered by motors operated by the automatic control. Either carbon or graphite electrodes are used, depending on the personal opinion of the man in charge. One company operating two plants uses carbon electroded at one works and graphite electrodes at the other. The furnace is lined with magnesite brick to a little above the slag line and from there up with silica brick, which are much cheaper and hold up better than the magnesite brick. The magnesite brick being basic and the silica brick acid, some furnacemen put one or two layers of neutral chrome brick between them. The spout is lined with firebrick which is not affected by the change of temperature as much as the other kinds of brick. A lining nine inches thick has been found to be the most economical. When an 18-inch lining was tried it lasted only about 20 per cent longer than the average 9-inch lining.

FIG. 5—CHARGING A 3-TON SNYDER FURNACE AT THE PLANT OF THE HUBBARD STEEL FOUNDRY CO., EAST CHICAGO, IND.

The top or roof usually consists of a ring made of channel steel, filled in either with silica blocks shaped specially for this purpose, or with the regular silica brick. Holes for the electrodes must be provided in the roof. Such a roof nine inches thick should last 70 heats or more but its life is to some extent dependent on the operator. An extra ring should be provided and a new roof always kept on hand in case of need in an emergency. In making up the roof a form is used to give the proper curve and to indicate the places for the electrode holes. This is frequently made of wood but at present some foundries are using a concrete form which is made on the floor near the furnace.

Making Bottom

Several different methods are used to put in the bottom. One company having foundries at three different places makes bottom in as many different ways. By one method a paste is made of magnesite with heated tar and rammed into the bottom of the steel shell with hot tampers. When starting with such a bottom care must be taken to lay in heavy pieces first, covering the surface with such stock. The first heat will take up carbon from the tar in the bottom to such an extent that frequently instead of trying to reduce the carbon the heat is poured into pigs and later gradually used up as scrap. Another method is to ram up several layers of a mixture of dolomite and slag, burning in each layer with the arcs. This is accomplished by laying pieces of electrodes on the bottom so that they come under each furnace electrode and make a path for the current to go from one electrode to the other. Fig. 6 illustrates how this would be arranged for a three-phase furnace. A very good bottom is made in this way but the heat that burns in the bottom is hard on the roof which softens and spalls more or less, depending on the skill of the furnaceman. Probably the best method of making a bottom is to line it with three layers of magnesite brick, filling in the crevices with powdered magnesite

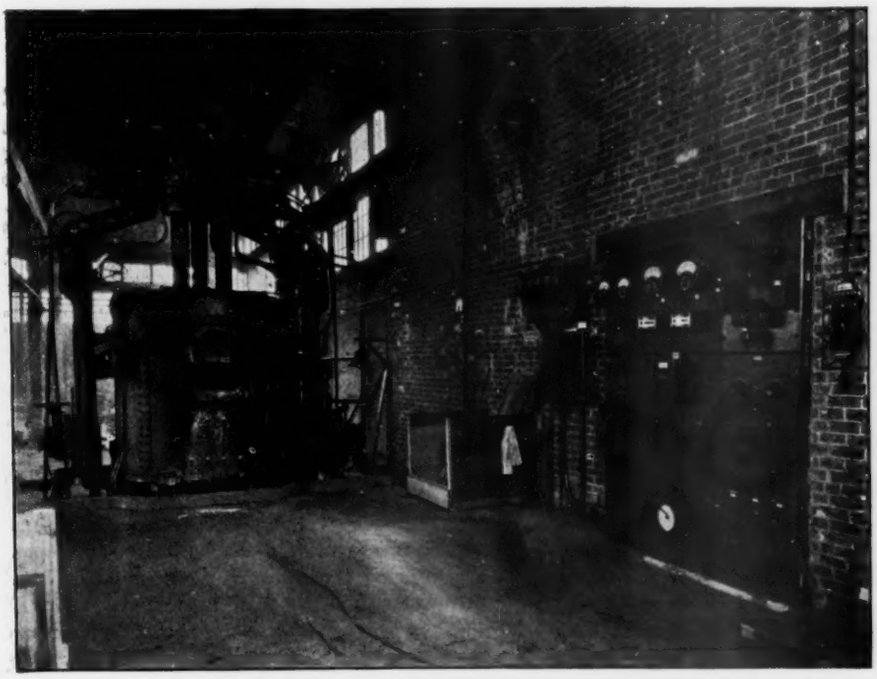


FIG. 4—REAR VIEW OF BOOTH-HALL FURNACE AT NEW ENGLAND STEEL CASTINGS CO., EAST LONGMEADOW, MASS.

and covering the bricks with a half-inch layer of the same material. When this is burned in, an even surface results.

As has been pointed out, one of the big advantages of the basic-lined furnace is that almost any kind of steel can be used, and the cost of the product is thus kept down. At a foundry where 20-ton acid open-hearth furnaces are operated, the electric furnace charges consist of 80 per cent turnings and 20 per cent gates and risers from castings made in the acid open hearth.

Under the present somewhat unusual conditions, if the market price of acid open-hearth scrap used by the electric furnace is charged up against it, and it is in turn credited with the market price for such low-phosphorus scrap as it makes, the cost of electric furnace steel is actually slightly under the cost of acid open-hearth steel.

In melting down the charge, considerable irregularity occurs in the arc until a pool of molten metal is formed under each electrode and the automatic control must be watched closely during this period. After a bath is formed, the control should need very little attention. Lime and fluorspar are thrown into the furnace during the melting down period to form a slag. At first the same voltage was used in melting down a charge as was used after the charge had melted. Recently the plan has been adopted of melting down with a higher voltage than is used after the charge is all melted. This can be done safely because the furnace and the charge before melting are at a lower temperature than they later attain. On the 6-ton Heroult furnaces with which the writer is familiar and to which all the figures given hereafter in this article will apply, 140-150 volts are used for melting down and 100-110 volts after the charge is melted.

Hitting the Right Carbon Point

When the charge is nearly melted down the melter can tell the approximate carbon contents by the fracture of the test piece which he pours into an open steel mold 1 x 4 inches at the bottom, two inches deep and one and one-half inches wide at the top. Before taking a final sample the melter should be careful to see that the steel is all melted and off the bottom, which can be done by poking a steel bar across the bottom of the furnace. Any steel remaining unmelted can easily be detected in this way. It should be the aim of the melter to have the carbon right when the charge is melted down, but it should rather be too low than too high, as it is much more trouble to reduce the carbon than to increase it. Reduction is brought about by the addition of hematite ore or mill scale which oxidizes the carbon, causing the metal to boil. This is a rather slow and tedious process and is sometimes helped along by putting a wooden pole into the bath to increase the boil.

Should the carbon be all right or too low, the next step depends upon whether it is desired to refine the metal further. If low-phosphorus, low-sulphur scrap has been used there will be no need of further refining for castings. In this case the slag, which is black with oxides, is lightened by throwing on it some form of carbon of such a gravity that its weight will not sink it through the slag into the metal. By doing this before the entire charge is melted considerable time is saved. Coke dust or powdered petroleum coke is used mixed with powdered lime. When the heat is entirely melted a sample of metal can be taken and sent to the laboratory where carbon and manganese determinations are made in from 15 to 20 minutes from the time the sample is poured. Should the carbon be under 0.25 per cent the amount can be estimated from the fracture, to within a point or two, and an analysis is unnecessary. Above this amount there is more or less chance of error, depending on the skill and experience of the melter. After the per cent of the carbon in the metal is determined it is brought up to the required amount by the addition of one of the denser forms of carbon, such as broken electrodes or pea coal. Manganese is also added and very little is lost, which would not have been the case had it been added while the slag was black. Enough silicon is also put in to kill the metal, and when it gets hot enough it is ready to pour.

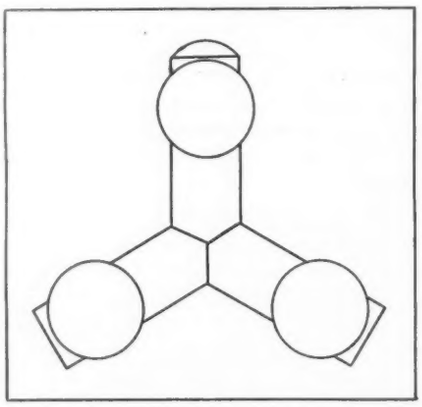


FIG. 6—SKETCH OF METHOD FOR BURNING IN BOTTOM

If it is desired to reduce the sulphur and phosphorus to a minimum, the slag which contains part of the sulphur and a large percentage of the phosphorus is skimmed off and a new slag made by the addition of lime and fluorspar. Not only does this second slag take up more sulphur and phosphorus but had the first slag been reduced in the furnace it would have given back to the metal nearly all the phosphorus it had taken up. It is not difficult to take off a slag when high carbon steel is being made, but the lower carbon steels set at such high temperatures that unless the slag is removed quickly and a new one put on at once, the metal freezes and considerable time is required to bring it back to the proper temperature.

When the metal is ready to pour, enough ferrosilicon is added to bring the silicon to the amount desired—0.20 to 0.30 per cent in metal for castings. Should the carbon still be a few points low it is raised by addition of a small amount of pig iron or wash metal, both of which contain approximately 4.0 per cent of carbon. The current is now turned off, the electrodes are raised and the furnace tilted. A small amount of powdered lime thrown on top of the ladle serves to stiffen the slag and keep some of the glare and heat off the craneman. A ladle addition of aluminum-titanium in the proportion of one pound to a ton has been found beneficial in reducing gas holes in the castings.

Electric furnace practice has taught the open-hearth melter some things, one of which is that steel can be made in the open hearth, using very little pig iron, by adding carbon to the charge. It carries lessons for the malleable foundryman also, and he is making use of some of these lessons as is seen in the fact that the National Malleable Castings Co., Cleveland, is melting iron in a cupola, blowing a portion of it in a side-blow converter and finally refining it in an electric furnace. When we realize that malleable iron could be made in an electric furnace from a charge made entirely of steel or malleable scrap, by the addition of carbon and ferrosilicon, we see that a broad field of practical research is open for the malleable foundryman.

Purchases Furnace Plant

The Newark Stamping & Foundry Co., Newark, O., has purchased the patterns, equipment, patents and good will of the May-Fieberger Co., Akron, O., manufacturers of hot air furnaces. This equipment now is being removed to the plant of the Newark Stamping & Foundry Co., at Newark. The capital stock of this company has been increased to $150,000 and a new building will be erected to afford added facilities.

V. L. Hollister, designer and contracting engineer, Lincoln, Nebr., is preparing plans for the erection of a large foundry to be built and equipped during the summer months. Mr. Hollister will be glad to receive catalogs, bulletins, etc., describing foundry equipment in general and he also is anxious to receive catalogs from foundry supply houses.

Diversified Output at Canton Plant

How a Large Foundry is Organized to Produce Castings Weighing from a Pound up to a Hundred Tons

LAST year while battles were being fought to settle the fate of the world and the American army was streaming across the seas to the rescue of civilization, the vital importance of speed and efficiency in handling materials was impressed on every man's mind. "Transport," an English word seldom met with in the United States prior to the war, greeted the eye and fell on the ear at almost every turn. The public soon learned that "transport" had a far broader meaning than its purely military connotation would seem to imply—its significance in shop operations became common knowledge so widespread was the interest in the production of war munitions. As a result, the rather prosaic problem of handling materials in industrial establishments fell under the spotlight and assumed an importance which its true relation to successful manufacturing entitles it. It is a subject which indeed merits continuous study. Applied to foundries it is specially important. "Success in the foundry field," a well known expert has said, "involves knowledge of the molding of sand, the melting of metals, the management of men and the handling of materials. Of these four factors, the last two are the most frequently neglected." Foundries which are usually well organized in these particulars, in which the problems of management and transportation have received special attention are, therefore, worthy of study and must inevitably possess features of interest. In this category is the steel-casting plant operated by the Canton Steel Foundry Co. at Canton, O.

This shop is equipped with three 40-ton acid open-hearth furnaces which have a melting capacity of 4200 tons per month. Facilities are available for the employment of 1500 men. Two shifts are run, and there are practically as many men on the night shift as on the day turn. The buildings cover 293,000 square feet of floor space. So thoroughly has the problem of handling materials been worked out that the melting, molding and cleaning departments are served by 21 traveling cranes, built by the Morgan Engineering Co., Alliance, O. These cranes range in capacity from 5 to 75 tons. Although this represents twice the crane equipment usually considered necessary for a shop of this size, each individual unit has proved its usefulness. Particularly was this true last summer when a tremendous number of castings were produced for direct war purposes. The management of the Canton Steel Foundry Co., attributes its success during this period partly to the excellent equipment for handling materials which was at its disposal, and which aided in speeding up the job all along the line. A tangible idea of the crane equipment in this foundry may be obtained by reference to the accompanying illustrations, particularly Figs. 4 and 9. It will be noted that the cranes are used not only for ordinary foundry purposes, but, where necessary, are equipped with magnets for handling metal and with single-line grab buckets for cutting over and distributing sand. The present works of the Canton Steel Foundry Co. is the result of

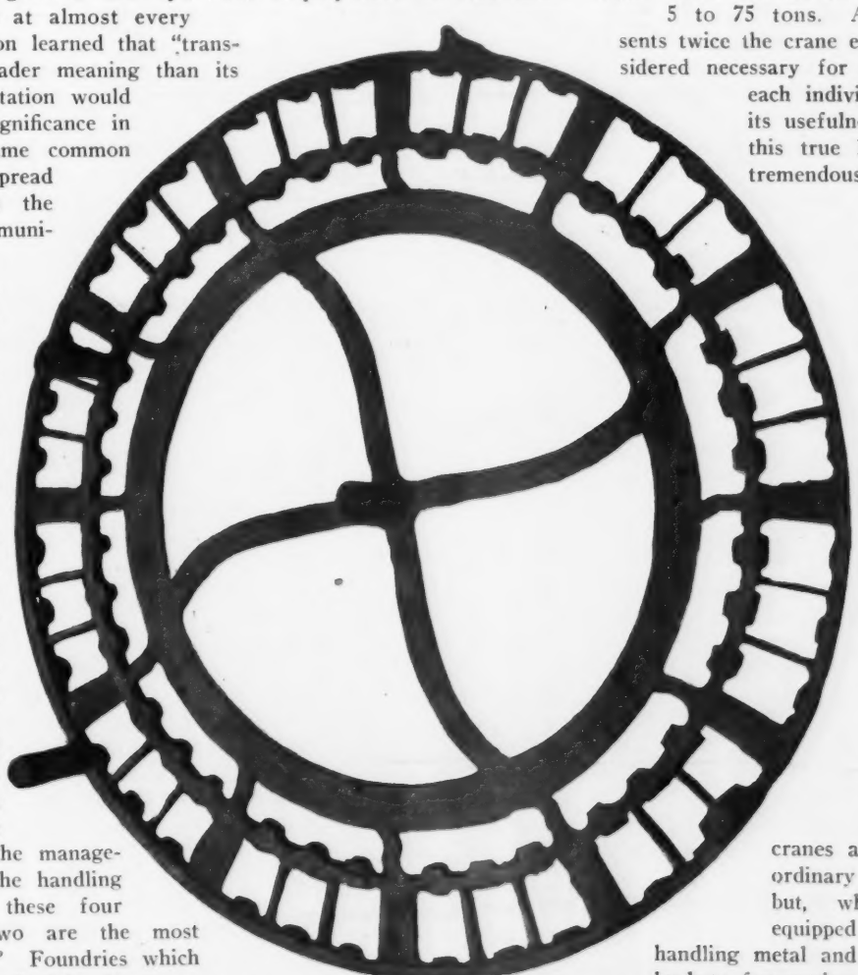


FIG. 1—A ROLLER-BEARING CAGE FOR A BIG GUN CAST IN ONE PIECE WEIGHT 800 POUNDS

over a decade of continuous growth. The plant was established under the name of the Shull Steel Castings & Mfg. Co. in 1906. About three years ago the controlling interest was purchased by a new management which has been specially active in developing the property, particularly in the direction of creating facilities for the large scale production of steel castings for builders of machinery of all kinds.

The plant now occupies a 40-acre site in the southern part of the city of Canton. A small stream borders long has been built across one end of the main building to house the cleaning department. This building was built by the Austin Co., Cleveland. A street, Allen avenue, runs along the westerly side of the property. Across this street from the main buildings a large pattern storage building has been erected together with a substantial brick office building. The latter is provided with special facilities for the engineering, drafting and executive forces, and also with conveniences for the employes, including a lunch room in the basement for the foremen and are returned, with proper notations, after each job is finished. The control clerk is thereby able to keep intimately in touch with the status and progress of each order. A provision for checking and if necessary altering each pattern as it passes from the pattern storage to the shop is an important feature of this system. The difficulties which arise from sending incorrect or incomplete patterns to the molding floor are thus avoided. The control system also makes possible the collection of important cost information. A complete description

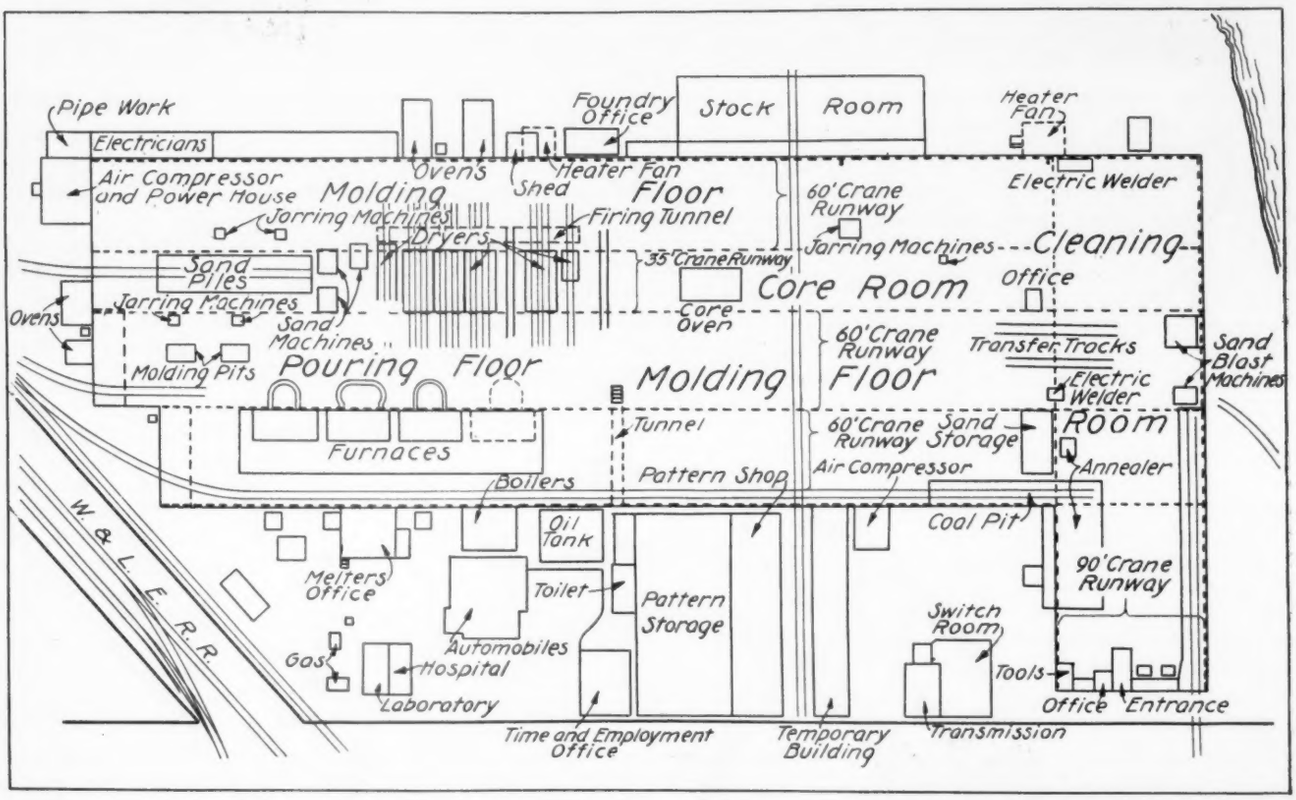


FIG. 2—PLAN OF MAIN BUILDING OF CANTON STEEL FOUNDRY SHOWING ARRANGEMENT OF OPEN-HEARTH FURNACES, SAND PITS, DRYING OVENS, MOLDING FLOORS, AND CLEANING ROOM

one side of the property and the resulting depression is being utilized as a dumping ground for foundry waste, which otherwise would have to be hauled away at considerable expense. The new level land thus created will be used for the erection of additional buildings as the company's plans for future expansion unfold. The tracks on the company's property connect with the Baltimore & Ohio, the Wheeling & Lake Erie and the Pennsylvania railroads, thus affording ample shipping facilities.

The main foundry building is a steel frame structure 700 feet long and 220 feet wide, with a gable roof of standard construction. It is divided into four bays, 65, 60, 35 and 60 feet wide respectively. Each bay is equipped with a crane runway. A cross bay 90 feet wide and 340 feet various department heads about the plant.

In order to handle patterns, flasks and work through the shop without congestion in any department, an ingenious and practical system of cost records and routing has been worked out. The nerve center of this system is the production office to which all customer's orders are referred. Immediately upon receipt, each order is transferred to a set of five standard forms which are made out in quintuplicate in one operation. These forms govern the movements of the pattern and core boxes, and therefore control the progress and routing of the order. A central station, or control desk, equipped with suitable filing facilities, is provided from which the various forms are sent out to the different departments engaged in turning out the work, and to which they of this system will be published in a later issue.

As previously mentioned, the melting department is equipped with three 40-ton acid open-hearth furnaces, arranged to burn either natural gas or fuel oil. These furnaces are located in the middle of one of the side bays, as indicated in Fig. 2. Space has been provided for the installation of a fourth furnace of the same size. The stockyard, where the scrap is stored and prepared, is located some distance from the main foundry building. This is illustrated in Fig. 13. It is equipped with a 15-ton traveling crane operating on a runway 400 feet long and 50 feet wide. This runway is now being extended to a length of 700 feet. The stockyard crane is provided with the usual magnet and skull-cracker equipment for auxiliary services.

FIG. 3—STEEL IS MELTED IN 40-TON OPEN-HEARTH FURNACES—SPECIAL LADLE-DRYING EQUIPMENT IS PROVIDED

At present all the scrap is loaded into standard railroad cars at the stock-yard and switched into the foundry, together with the pig iron and other raw materials, where it is unloaded in the open-hearth furnace bay in a space set aside at the end of the charging platform. This space is served by the traveling cranes that cover the entire furnace bay. The charging boxes, which are cast steel, are loaded at this point and transferred to the charging platform by the cranes. This arrangement makes it possible for the boxes to be loaded directly under the eye of the melter; it also permits of the storage of a considerable quantity of raw material in a convenient position alongside the furnaces, under cover and out of the weather.

This scheme of operations, however, has certain disadvantages, including the tying-up of railroad equipment, and is now being superseded by a system which it is believed will serve even better. To handle the furnace charges by the new method, a gasoline-driven locomotive has been purchased to operate between the stock-yard and the foundry, and in order to relieve the traveling cranes, an escalator is being installed to pull the buggies from the ground level up to the charging floor, where they are manipulated by a 5-ton high-type Morgan charging machine. Three

FIG. 4—ONE OF THE MAIN MOLDING BAYS IS 60 FEET WIDE AND 600 FEET LONG—IT IS SERVED BY FOUR TRAVELING CRANES

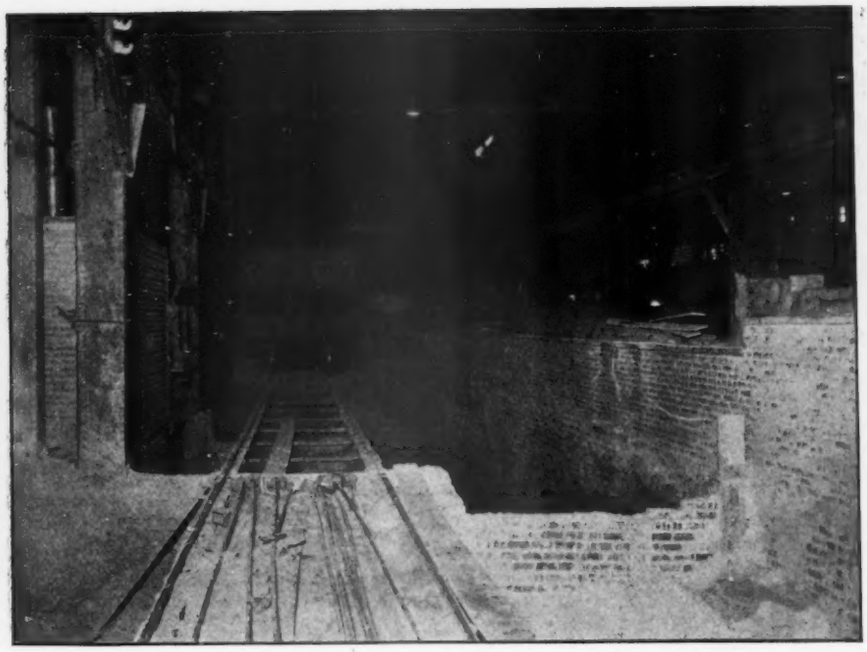


FIG. 5—SAND IS RECEIVED IN HOPPER-BOTTOM CARS AND UNLOADED DIRECTLY INTO STORAGE BINS INSIDE THE FOUNDRY

charging boxes are handled on each buggy. Standard gage tracks are used.

The 40-ton acid open-hearth furnaces previously mentioned are illustrated in Fig. 3. These furnaces present no unusual features. They are designed along standard lines. Three kinds of fuel are employed, natural gas, fuel oil, and producer gas. The latter is very rarely used. In fact the gas producer equipment is never operated except in extreme emergencies. Until last year when the consumption of gas for industrial purposes was forbidden on account of the limited supply for domestic heating purposes natural gas was used in the summer and fuel oil in the winter. This condition may make it necessary to use oil continuously hereafter. Although gas until recently had the advantage, like electricity, of being constantly available in any quantity, oil fuel also has its advantages in that it offers a more concentrated form of heat and can be stored against emergencies. Using oil fuel, the heats are melted down from cold stock at the Canton foundry in 7½ hours. With natural gas, from two to three hours more are required to complete a heat of steel.

The heats are handled according to standard open-hearth steel foundry methods. Great care is taken to produce metal of satisfactory composition. To this end, no ladle additions except ferrosilicon are permitted. The melter, therefore, is obliged to bring the steel to the proper composition as to carbon and manganese before it is tapped from the furnace. Various kinds of alloy steels in addition to plain carbon steel frequently are made. In fact the company is in a position to make any grade of steel which may be specified by purchasers of castings. To assist in turning out heats of the desired composition, as well as to assure the production of steel with proper physical qualities, a completely equipped laboratory is maintained for making the routine analyses required in connection with the operation of the open-hearth furnaces, and for research work in metallurgy and heat treating. For the latter purpose, a small electric furnace is installed and complete pyrometer equipment provided in the laboratory.

In the Canton foundry, the use of pyrometers is not confined exclusively to the laboratory. In addition they are used every day in the operation of the open-hearth furnaces, mold-drying ovens, annealing furnaces, etc. In fact the extensive employment of heat measuring instruments constitutes one of the features of this plant. As a result, guesswork is eliminated to a large extent and definite results are obtained in melting, annealing and drying operations.

An individual recording pyrometer is attached to each open-hearth furnace. The recording instruments are located in the office of the general superintendent who is thereby furnished with a complete and continuous record of the activities of the melting department. A separate thermocouple is installed in the checker-work of each furnace. The pyrometers, therefore, measure the temperature of the outgoing gases immediately after they leave the melting chamber. In this way the superintendent is able to detect any irregular action of the furnace which affects the temperature. The pyrometers were furnished by the Brown Instrument Co., Philadelphia.

One of the charts made by the recording instrument is illustrated in Fig. 12. It shows how frequently and how regularly the furnace was reversed. It also indicates that the furnace was closed down from about 8 o'clock in the evening until nearly midnight when it was started up again. The irregularity shown on the chart around noon, tells when the first heat was cast. It will be noted that the second heat came out in a little shorter time, around 8 p. m.

The annealing and mold-drying fur-

FIG. 6—A PORTION OF MOLDING FLOOR SHOWING SHELVES FOR HOLDING LIVE PATTERNS AWAITING PRODUCTION

naces are equipped with pyrometers, which give the operator the correct temperature. These instruments are considerably less complicated than the recording type, and consequently are less expensive to install and maintain. One indicating instrument serves for all of the thermocouples in the annealing furnaces, while a single additional instrument serves the drying ovens. The company realizes that pyrometers may cause a great deal of trouble and loss if they are allowed to become inaccurate. Therefore, arrangements have been made with the Brown Instrument Co. to have the pyrometers checked monthly.

The space in front of the open-hearth furnaces is used for pouring-off molds which are delivered from the drying ovens opposite or brought up from other parts of the foundry. Extra large molds, of course, are made as near the furnace as possible. Fig. 3 illustrates a portion of the pouring bay and also shows the arrangement for drying the ladles by means of gas or oil flames. Ladles to be dried are placed on cars which carry them under the drying hoods or covers. The latter, three in number, are suspended from a specially built structural steel framework located in front of the first and second open-hearth furnaces. This arrangement makes it unnecessary to ever move drying covers or to disturb the burners. At the same time the ladles may be readily shoved in and out of drying position on the cars which run on tracks laid across the foundry floor. For handling the molten metal, two 40-ton and three 60-ton ladles are provided.

In this part of the foundry a great many molds must be moved; ample facilities also are necessary for handling the metal promptly after it is tapped. These requirements are met by a full complement of cranes—two 10-ton, one 15-ton, two 35-ton and one 75-ton. This is the largest number of cranes in any one department of the foundry.

FIG. 8—THE MOLD-DRYING OVENS ARE OF THE DOUBLE-ENDED TYPE WITH COUNTERBALANCED STEEL-PLATE DOORS—THEY ARE FIRED BY GAS OR FUEL OIL

A Concrete Lined Pit

As previously mentioned, the pouring bay in front of the open-hearth furnaces is also used for heavy molding. For this purpose, two unusually large concrete-lined molding pits have been provided. The largest of these pits is 30 feet long, 24 feet wide and 19 feet deep. The other is only slightly smaller. The heaviest sort of a pit job may be handled easily. Steel rolls of all sizes are made; in fact rolls are one of the specialties to which particular attention is paid. They are molded and cast vertically in the pits in the customary manner, using the dry-sand process. Ingots for forging up to 26 feet in length also are cast, together with large rolling mill housings and other heavy machinery castings, which usually are molded close to the furnaces. These heavy weights are readily handled by means of the 75-ton crane, with which this department is equipped, aided by the 35-ton crane, the two when yoked together being able to handle weights up to 100 tons.

FIG. 7—FIRING TUNNEL UNDER FLOOR IN FRONT OF MOLD-DRYING OVENS, SHOWING ARRANGEMENT OF BURNERS

A great variety of work is handled at the Canton plant, and in the production of extra heavy machinery castings, intricate foundry problems are encountered. The roll housing shown in Fig. 11 presented some difficulty in casting. This housing weighed 182,525 pounds. To get this amount of metal into the mold quickly, two ladles were used at one end and one at the other end, the latter pouring through a double runner box. A special frame was constructed to support one of the ladles during the pouring operation. The other two were handled by cranes. Four days were required to clean this casting after it was removed from the sand.

Another exceedingly interesting casting is shown in Fig. 1. It is a spacer ring, or roller cage for the roller bearing under a 12-inch mortar mount. A large number of these cast-

FIG. 9—A GENERAL VIEW IN THE CLEANING ROOM SHOWING ANNEALING FURNACES AT THE LEFT, AND SAND-BLAST APPARATUS AT THE RIGHT

ings were turned out for the government at the Canton foundry during the war. Inasmuch as these rings serve as roller cages, they must lie perfectly flat and also be true both concentrically and as to diameter. The casting, when finished, consists simply of outer and inner rings tied together by ¾-inch bars, every third bar being made 4 inches wide for stiffening purposes. There are, therefore, 12 stiffener bars and 24 small ¾-inch bars in each casting. The outer and inner rings also are cast with bosses in which the spindles of the rollers rotate as shown in Fig. 1. This illustration shows a third or innermost ring which is not part of the casting but merely a portion of the gating system. The outer ring of the casting is 100 inches in diameter and the inner ring 80 inches.

The finished weight of this casting, nearly 9 feet in diameter, is approximately 800 pounds. The metal is spread out, however, through a great many thin sections, and at first it was thought the casting would have to be made in four parts. But after considerable study, it was decided to mold it in one piece. This was tried and the results were successful. The metal was all poured through a down-gate in the center of the mold. This down-gate, or central sprue, it will be noted by reference to Fig. 1, is connected to the ring gate, which is concentric with the inner ring of the casting, by four runners. The diameter of the ring gate is 68 inches. The runners were cast with a slight swirl, so they would yield and relieve the strain on cooling. The ring gate was connected to the inner ring of the casting by 12 finger gates. The ring gate has a comparatively heavy section, and therefore, remained molten long enough to feed the casting as it set.

The casting was allowed to cool gradually in the sand. On being taken out it was handled by the central sprue which was left on for this purpose until it reached the machine shop. Great care had to be taken from the time the casting was poured until it was ready to ship to prevent warping or bending. It had to be very carefully blocked up while being annealed.

Large Molding Floor Area

A large number of smaller castings, which present no special features, are turned out in the Canton foundry every month. The plant, in fact, is equipped to make castings from one pound to 100 tons in weight. The facilities for handling small work on a quantity production basis are designed to fit almost any demands which may be made upon the plant. Including the pouring-off space in front of the open-hearth furnaces, the actual molding floor area approximates 72,000 square feet at the present time. When the new method for handling the furnace charges is in operation, the space at the end of the furnace platform now used for storing scrap, etc., will be released, increasing the molding floor area by 18,000 square feet, to a total of over 90,000 square feet.

The arrangement of the molding floor space is clearly indicated in Fig. 2. As this illustration shows, the drying ovens and molding-sand pits are located in that part of the 35-foot bay, opposite the open-hearth furnaces. The other end of this narrow bay, nearest the cleaning room, is devoted to coremaking. The core room, therefore, is centrally located with reference to the various molding floors. The entire 60 x 300-foot bay beyond the 35-foot bay is devoted to molding, that portion opposite the drying ovens and sand pits being used for dry-sand work, and the remainder for green-sand molding. The drying ovens are of the double ended type, and the molds are set out for pouring on the floor in front of the open-hearth furnaces as previously described. The remainder of the pouring-floor bay, alongside the core room, is used for miscellaneous molding, mostly in green sand.

Each of these floors is amply served

FIG. 10—A PORTION OF THE CENTRAL BAY IS SET ASIDE FOR COREMAKING—THIS DEPARTMENT IS CONVENIENTLY LOCATED IN THE CENTER OF THE SHOP

by traveling cranes of various sizes as previously described. The crane equipment for the big 60 x 600-foot combination dry and green sand bay is clearly shown in Fig. 4. Of the four cranes in this department, one has a capacity of 20 tons, one 15 tons, and two 10 tons. Incidentally as shown in Fig. 4 each crane is equipped with special fire fighting apparatus which is kept constantly in readiness for extinguishing fires in the roof or other upper parts of the building which cannot readily be reached from the ground. The extinguishers are carried in special racks on each crane, the racks or carriers being plainly labeled "Chemical Engine." The several molding floors are provided with jarring machines located at convenient points. Six machines, furnished by the Herman Pneumatic Machine Co., Pittsburgh, are installed.

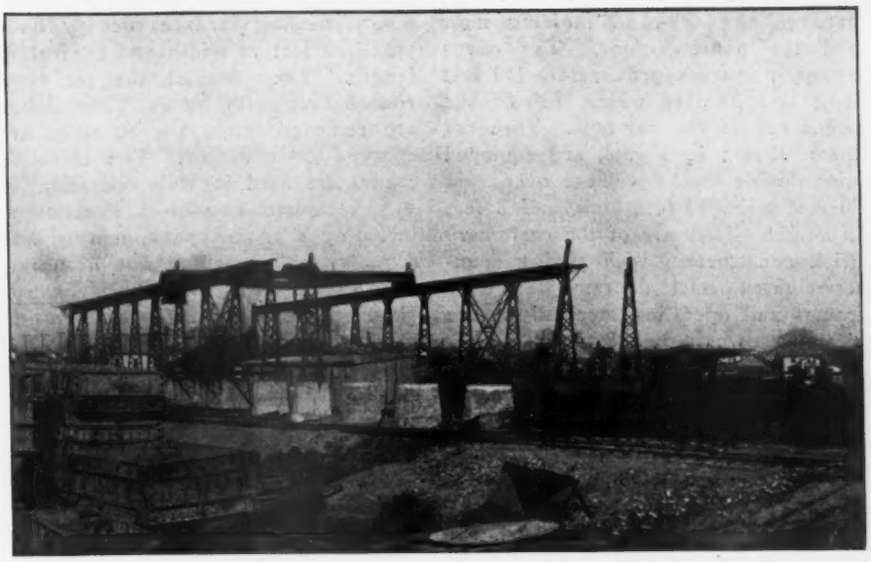


FIG. 13—STOCKYARD FOR STORAGE OF OPEN-HEARTH FURNACE SCRAP WITH OVERHEAD TRAVELING CRANE

Centralized Sand-Handling Facilities

Further evidence of the thought which has been given the problem of economically handling materials in the Canton foundry is found in the sand-storage and distributing system. The sand bins shown in Fig. 5, occupy a portion of the 35-foot central bay, opposite the open-hearth furnaces. There are four bins with an overall length of approximately 100 feet and a width of 25 feet. The bins are of brick construction. The sand is shipped in hopper-bottom cars, which are brought into the building and spotted over the bins into which the sand is to be discharged. This arrangement practically eliminates unloading expense. For distribution to the various floors and to the sand-mixing machines, the sand is picked up by grab-buckets operated from the traveling crane; where necessary, tote boxes handled by the cranes also are used. The tote boxes, which are of steel construction, are fitted with heavy bails which facilitate their transfer by crane.

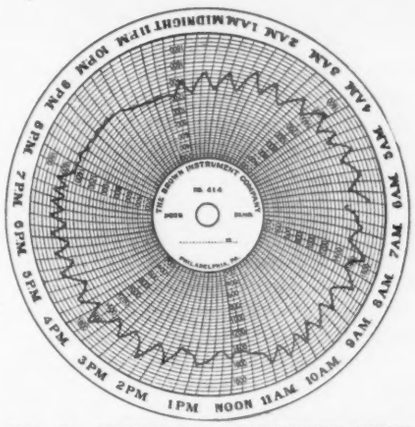


FIG. 12—OPEN-HEARTH TEMPERATURE CHART

The outer portion of this chart, which runs to 3000 degrees, has been removed to save space

Three sand-mixing machines of the muller type are installed at the inner end of the sand bins. All of the facing sand is first passed through these machines before it is distributed to the floors.

Ranged alongside the sand bins, but facing the molding bay, as shown in Fig. 6, is a set of shelves on which the active or ordered-up patterns are placed while waiting distribution to the molders. This insures the live patterns being readily accessible when they are needed and also gives the foremen a visual conception of the volume of work ahead. In fact the efficiency of the shop, as far as production is concerned, may be said to vary inversely with the number of patterns on these shelves. The patterns are distributed to the proper points throughout the shop by means of the cranes. For this purpose steel-strapped wooden boxes similar to that shown in Fig 6 are employed. Some large patterns, as well as a certain number of patterns for rush jobs, go direct from the pattern checking room, adjacent to the production office, to the floors without being sent to the ordered-up shelves.

FIG. 11—A CAST STEEL ROLLING-MILL HOUSING WEIGHING 182,525 POUNDS AS IT CAME FROM THE SAND

Fireman Has Nothnig to Do

The mold-drying facilities, which are ample, form one of the interesting features of this plant. Six drying ovens have been installed. They are all located opposite the open-hearth

furnaces, in the 35-foot central bay, between the dry-sand molding floor and the pouring floor. The ovens occupy a space approximately 140 feet long and 25 feet wide. All of the ovens are of the car-type. Three of them, shown in Fig. 8, are equipped with double tracks. These ovens are 20 feet wide, 40 feet long, and 8 feet in height. They are of the customary brick construction with sliding counterweighted steel doors. The door frames and operating mechanisms are clearly shown in Fig. 8.

Grouping the drying ovens in one part of the shop has made it possible to work out a unified system of firing. Natural gas or fuel oil is used, depending upon circumstances previously described. This form of fuel is especially satisfactory for drying ovens inasmuch as the temperature can readily be controlled.

To accommodate the burners, and for the convenience of the fireman, a tunnel or subway approximately 8 feet wide, 7 feet high and 130 feet in length has been built under the molding floor along the entire length of the battery of ovens. The general arrangement of this subway, together with the oven burners is shown in Fig. 7. One fireman handles the entire job and has practically nothing to do aside from regulating the flames occasionally. To assist him in maintaining a proper temperature, a Brown pyrometer installation has been provided, a 12-point indicating pyrometer being located at a central position in the subway. Each drying oven is equipped with two thermocouples. The operator keeps a record of the temperatures which is forwarded daily to the superintendent.

The core room, Fig. 10, is equipped with two oil-fired, car-type ovens together with a small jarring machine and other equipment for making large and small cores. Two 5-ton cranes serve this department. The core room is located in the 35-foot bay between the two main folding floors as previously described. One of the several standard gage railroad tracks which enter the foundry cuts across the center of the core room.

The cleaning room, which has a floor area of 17,000 square feet, is equipped with one 50-ton and two 15-ton traveling cranes, together with annealing furnaces of ample size, sand-blast apparatus, etc. The annealing furnaces, which are shown to the left of Fig. 9, are fired at present by coal burned on grates in the ordinary manner. This arrangement shortly will be superseded by complete powdered coal installation which is expected to effect economies in fuel consumption, and also to improve the temperature control of the furnaces. The annealing furnaces occupy floor space 30 feet in width and 80 feet in length. They are of the pit type, roofed over with bungs. The bungs are removed when the furnaces are charged or unloaded. The traveling cranes are used for this operation.

A complete sand-blast installation, including a room-type apparatus, and a rotary-table machine, has been furnished by the Pangborn Corp., Hagerstown, Md. A raised grating has been installed adjacent to the rotary-table machine for cleaning small castings which might otherwise be lost. A full complement of pneumatic tools also is included in the equipment of the cleaning department. A track over which castings may be shipped, enters one corner of the cleaning room, as shown in Fig. 9.

Like many other concerns, the Canton Steel Foundry Co., did a great deal of work for the government during the war. Although this included considerable indirect work, such rolling-mill housings, a large number of castings also were made for purely military purposes. In this catagory were included a large number of mounts for 6-inch, 8-inch and 12-inch mortars. The order for 12-inch mortars called for 91 mounts. All of the government's castings were made to meet the specifications of the ordnance department. This experience naturally will be of considerable value in handling the difficult work growing out of the reconstruction period through which the country is now passing.

Compulsory Costing

By Dr. Robert Grimshaw

Many foundrymen are satisfied with their present cost systems, or their lack of any system of figuring costs; but aside from the elimination of the *flat price* enormity, which can only be discarded by having job, or at least class costing, there are several reasons why the adoption of some accurate, readily comprehensible and standard costing system will soon be compulsory. These lie with our esteemed Uncle Samuel, who has a direct and undeniable interest.

When the news-print paper manufacturers went to Washington with individual and class grievances not entirely unconnected with the tax question, they were met by a most unwelcome Missourian attitude on the part of the "powers that be," who intimated that in running a pulp mill and a paper mill, the former selling to the latter as well as to outsiders, or perhaps only to the paper mill, no manufacturer was justified in charging one profit on the pulp as such, and another thereon in the form of paper. They also gave the manufacturers the proverbial "hint with a fence paling" that instead of their 57 varieties of costing they should adopt one standard method by which the profits of all might be calculated and gaged. Until there was such a uniform system, they might swallow their grievance—themselves too, if they chose.

So the paper manufacturers, emulating that Duke of York who

"With twice 10,000 men
Marched up the hill, then marched back again,"

again went back to their several homes and employed an expert accountant, familiar with pulp and paper making, to evolve a cost system which would give the cost of each stage of manufacture from standing timber to the shipping platform. Now they—and the tax experts—know "where they are at."

And so the ultimatum soon will come to all foundrymen who have been producing on the *cost plus* basis, and those who contemplate taking contracts on the *maximum and minimum* profit plan, as well as those others who have no contracts, but who will find their necks under that neat little 80 per cent ax, that they must have a standard cost system which will replace the "by guess and by gosh" way that so many find "good enough."

Installs Furnace in Mexico

The McLain-Carter Furnace Co., Goldsmith building, Milwaukee, has closed a contract with Hijos de Valentin Elcoro, Mexico City, Mexico, for a 5-ton oil-burning open-hearth furnace of the McLain-Carter type. A 10-ton basic furnace for heating 4 x 4-inch billets also is being installed by the McLain-Carter Co. at the plant of the Fort Dodge Culvert & Iron Mills Co., Fort Dodge, Iowa.

Establishes St. Louis Office

The Warren Steel Casting Co., St. Louis, manufacturer of electric and open-hearth steel castings, has established its general sales office in the Boatmen's Bank building, St. Louis, in charge of J. P. Pero Jr., vice president and sales manager. Other sales offices also are located in the Railway Exchange building, Chicago, and the Book building, Detroit.

Improvements recently have been completed at the by-product coke plant of the Camden Coke Co., Camden, N. J. The company now is able to produce 625 tons of coke per day and is able to guarantee less than 11 per cent ash and less than 1 per cent sulphur content in its product.

Making Castings Used in Ship Construction---I

Details of Making the Rudder Pattern by Two Different Methods and a Description of the Core Box Construction—British Practice is Discussed

By Ben Shaw and James Edgar

AT the beginning of the war the number of foundries in England that could cope with large steel casting work was comparatively small, but it was probably sufficient for normal needs. As the necessity for more ships whether for the navy or merchant service, became much more imperative, owing chiefly to the submarine warfare, the pressing need for increased production to meet with the great demands caused by the war caused the large foundries to become congested with work, and the small foundries had to adapt themselves to a class of work not only differing in size, but also in design from that to which they were accustomed. Steel is probably the most uncertain of the common metals to cast and the construction of the necessary patterns and the subsequent molding differ so much in large and small work, that successful results can only be obtained after considerable experience, and by the exercise of an unusual amount of initiative.

In the foundry not only the manipulative work of molding, but the question of the design of intricate castings is of considerable importance. In the actual preparation of the molds, especially for steel castings, it is the little things that count, and in the design of these castings unequal cooling has to be more guarded against than with other metals.

The patterns for large cast steel work occasionally are conveyed by rail from the shipyard to the foundry, because in many cases the correct shapes and sizes are taken from the ship in course of construction or from specially prepared molds of a portion of the ship, with which the required casting is to come into contact. When these foundries are at a considerable distance from the shipyard, much delay is caused in the transportation of the patterns and they frequently are damaged in handling. Consequently, the foundry responsible for the casting, frequently undertakes the pattern work.

The necessity for accuracy in the thickness of the metal in this class of work is not great, but angles are important. The patterns are difficult to handle because of their size and the patternmaker must have the ability to build the pattern to obtain the maximum of strength. This is more essential with this class of work than with large engine work, because the designs are such that if the finished work yields, it is practically impossible to get it correct again.

Many of the iron foundries in England are of sufficient size to undertake the installation of steel departments, and there is no reason why they cannot also undertake the necessary patternmaking for producing ship castings. In this connection there is less difference between iron and steel than there is between iron and nonferrous metals, and the average iron foundry can adapt itself to brass work. Large iron foundries have practically all the plant necessary for steel work except the steel furnaces, and with a few experienced steel molders should be able to cope with any steel work, however large.

With reference to the relative merits of forgings and castings, it may be truly stated that each has positive advantages over the other. The balance of opinion now, however, is in favor of castings. They are generally cheaper than forgings and this is true even when the patternmaking costs are heavy. The risk, however, is greater, because even with the greatest care bad castings sometimes are made, causing delay in delivery, and this occasionally influences shipbuilders in favor of forgings. There is also an element of uncertainty with castings, as there are occasionally internal defects not noticeable on the face. It is a mistake to suppose that forgings are not also subject to internal strains, and welded joints on large work are not very reliable. However, there is a class of work which does not permit of an alternative method, and because of its design castings are necessary. Indeed, casting gives far greater scope to the designer than forging. It is often possible to lighten the casting by coring without interfering with its strength, and it gives a piece of work a more graceful shape if it is cast; an example of this is the propeller bracket, the fish-back or arm of which frequently is hollowed out.

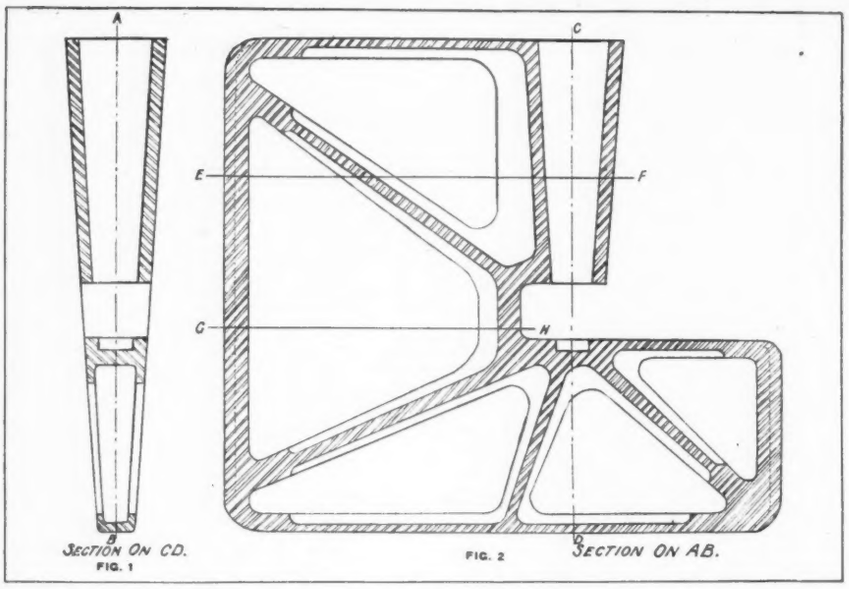
In this series of articles both the patternmaking and molding of large steel castings for shipbuilding purposes, as carried on in England will be described and discussed, and influencing features of design are noted.

Making the Rudder Pattern

A REPRESENTATIVE type of rudder is shown in Figs. 1 to 6. The outline of rudders vary somewhat, but the main features of their design are the same and the methods pursued in making the pattern for this type are equally applicable to almost any rudder. Reference to Figs. 1 and 2, bearing in mind that the height *AB* may be 12 or 14 feet, will give an idea of how frail the pattern is and the care which must be exercised in building it to prevent it from breaking or twisting. There are two ways by which the pattern may be made, and that adopted must depend on the foundry which is going to cast the work. In some districts in England it is the practice to make all large patterns for steel exact models of the finished casting. The great advantage of this, especially when dealing with awkward shapes, is that the correct thickness of metal is assured. Furthermore, the molder sees his work more clearly and can mark his course at the beginning of the job with greater confidence. However, it is a slow method. If a block pattern is made, and the cores are made in separate boxes, the work can be better distributed. The latter method, however, is the more expensive in the pattern shop, although the foundry, of course, is the first consideration.

Making a Block Pattern

We shall consider making a block pattern first, although the initial step is the same, whatever method is adopted. The common practice is for the molding loft to supply the pattern shop with a template. A drawing is provided, but for the main sizes, the template is more reliable, as it is frequently found necessary, when the frames are laid out on the molding loft floor, to change the design in places. It is not necessary, however, nor is it advisable, to lay out the work on a drawing board. The drawing should be done on the floor and on top of this drawing the work is built. The simplest way is to screw the template to the floor and mark a line round it. The template, of course, is the finished shape of the rudder, and the patternmaker has to allow for contraction. The easiest way to do this is to draw the center line *CD*, Fig. 2, to measure all sizes at right angles to this line with a standard rule and then to transfer the size to the contraction rule. The sizes in the other direction, that is, in the height of the rudder, can be measured from a base line. The sec-



FIGS. 1 AND 2—SECTIONAL VIEWS OF A RUDDER PATTERN, FROM 12 TO 14 FEET IN HEIGHT

tion *CD*, Fig. 2, may be laid out alongside the front elevation, but it is advisable to put the other sections, Figs. 3, 4, 5 and 6, on top of the elevation. In painting the drawing, which is necessary as it would otherwise become faint before the job is finished, the sections can be colored differently than the main view.

For the purpose of this article we shall suppose that the whole job is being made by one or two men, although in the average shop quite a few men would be employed on it. The joint frames should be made first. It should be explained, however, that there is a considerable difference between the top and bottom halves. Prints are only put on the bottom half as they are unnecessary on the top half, apart from the danger of crushing when the cope is being lowered. Reference to Figs. 9 and 10 will show the main differences. Fig. 9, the top, is covered all over, as it is easier for the patternmaker to cover it with plates than for the molder to fill it with loam, but the bottom, on the other hand, does not need to be covered.

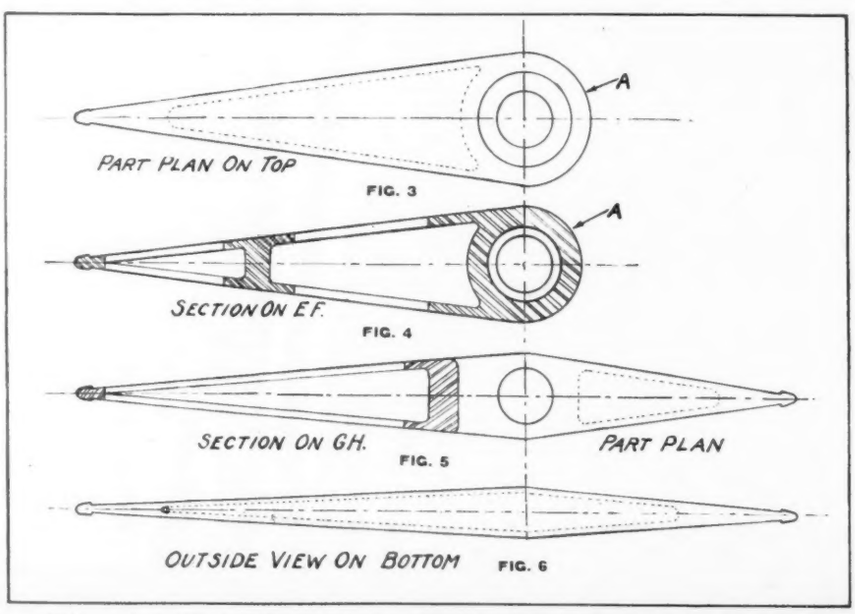
Constructing Joint Frames

The difference in construction begins with the joint frames. An extra piece, *AF*, Fig. 8, is half-lapped on the frames to support the ribs *BC* and *D*. A similar piece could be put on the other frame, but it is not necessary. These frames should not be less than 1⅝ inches in thickness, thus allowing 1½-inch screws to be used. Care should be taken to prevent the half laps from being too tight. It is peculiar that craftsmen who are careful to leave open joints when joining timber, edge to edge, will persist in making close half laps. Joints on the outside of a frame like *AA*, Fig. 7, may be close to preserve the correct shape of the frame, but all other joints, such as *B*, Fig. 7, where the side grain is enclosed on both sides, should be left 1/16 or ⅛-inch open depending upon the width of the rails. If this is not done, when the pattern goes into the damp sand the wood will swell and the frame will warp and alter the shape of the whole job. The frames, when the work is finally shaped off, will be reduced considerably, as indicated by *C*, Fig. 11, and the half laps at this end will have to be cut so that an equal joint will be left. It is unwise, if not impossible, to screw the joints *CCC*, Figs. 7 and 8, but it is not wise to rely upon glue only. The best job is obtained by using lead rivets. They are easily made and as easily attached. A piece of 3/16 or ¼-inch lead wire is cut to convenient lengths. When the holes are bored with a shell bit, a plate is placed under the frame, a rivet inserted and hammered down. It is an improvement to countersink the hole on the face of the frame. The lead rivets will chisel or plane nicely. If lead wire is not handy, wooden pegs should be used. If ¼-inch holes are bored and the pegs are made ¼-inch square and pointed, they will make a fairly strong job, but they cannot be compared to lead rivets.

Making the Boss

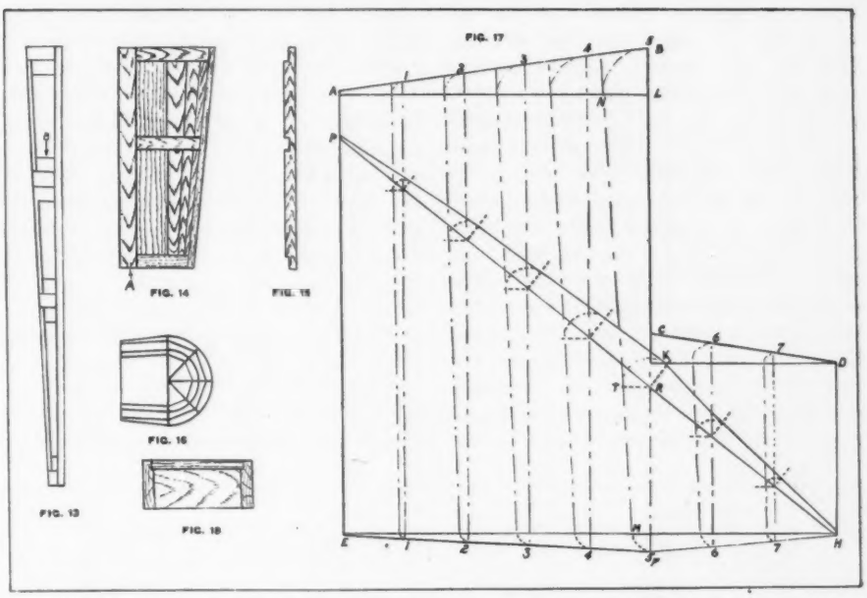
The best way to make the boss, *A*, Figs. 3 and 4, is to make cleats and screw staves onto them. Of course the inner side will be cored. An end view showing the construction is shown in Fig. 11. To get the correct shape of the cleats, and the taper of the staves, it is advisable to lay out an end view, Fig. 16. Three of these cleats are shown in Fig. 14, and they will probably be sufficient, but an extra one may be put in rather than have them more than 18 inches apart. If they are too wide apart the lagging will yield. If the cleats are fairly thick, say 2 inches, the lagging need only be ¾ or ⅞-inch thick. It is advisable to have one stay checked onto the face, as shown at *A*, Fig. 14. A view of this stay is shown in Fig. 15.

The circular portion of the barrels should be finished before they are screwed to the frames, but the flat top may be left full so that it can be planed off when the pattern has been built. Before the barrels are screwed in place, the cleats which will define the shape of the rudder must be made. They should be constructed of 2-inch tim-



FIGS. 3, 4, 5 AND 6—PART PLAN AND SECTIONAL VIEWS OF THE TOP AND BOTTOM OF A RUDDER PATTERN

ber. Cleats for the bottom half do not present any difficulty, as they may be placed where the sections are made. It would be quite possible, when making the cleats to allow for the ¾-inch covering plates, or lagging as it is sometimes called, to be screwed on top, but the alternative and probably stronger way is to make the cleats the full width and after they are screwed in position, to fit resting pieces for the lagging against them, as shown at *B*, Fig. 9. The great gain of this method is that there is no end grain to tear the mold when the pattern is being drawn. A combination of the two methods is possible by making the outer cleats the full width and reducing the inner ones so that the lagging can be carried across, the only disadvantage of this being that the cleats cannot be tested with a straightedge as easily as when they are all the same height.

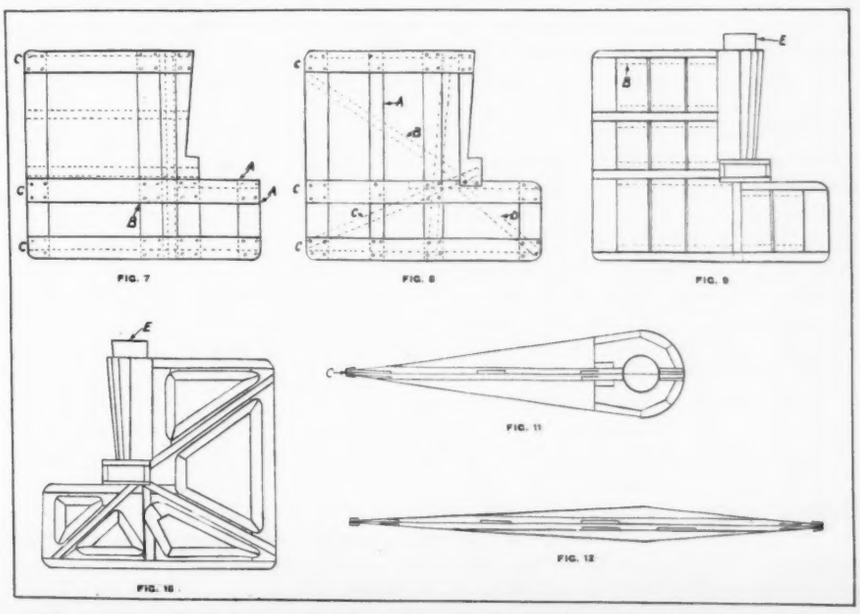


FIGS. 13, 14, 15, 16 AND 18—VIEWS OF VARIOUS PARTS OF THE PATTERN FIG. 17 IS AN OUTLINE OF THE RUDDER PATTERN

Attaching the Lagging

The lagging either can be screwed or nailed, and open joints should be made. The barrel now may be screwed into position and the entire top cleaned off with a plane. There is still the print, *A*, to make. It is advisable to make a print on both top and bottom for this core. The danger of crushing this core is not very great, and having a top as well as a bottom print simplifies the making of the core box. It will be noted that the top is set into the sides. A section of the print showing the sides checked for the top is shown in Fig. 18. The principle involved in setting-in the top instead of making it to the outside of the print, and that which determined us to fit the body lagging to the inside of the outer cleats is the same. It is never wise to have end grain, and side grain together on the side of a mold. Even if the work is well painted and varnished, the side grain will shrink and swell, as it absorbs moisture or is dried, and if it does not spoil the mold it involves repairs that can be avoided. It is not always possible, however, without involving much labor, to act on this principle, as for example, a barrel end where the staves are carried across to the outside of the cleats, but whenever possible, the grain of different thicknesses of timber should not be crossed. Some craftsmen, in jointing timber, cross them in the belief that this is the best way to prevent the work warping, whereas the more effective way is to joint different thicknesses with the grain running in the same direction but back-to-back, that is, with the annular rings of the different pieces tangent to each other.

The top half being now finished the bottom half may be built. The position of the cleats on this half, with the exception of the outer ones, *ABC*, are determined by the shape of the cores. The correct shape of these diagonal cleats can be found by simple projection. Some craftsmen are content, in a case of this kind, to screw on the outer cleats and after roughing down the diagonal cleats, to finish them off in place, using a straightedge across the job. This is a clumsy and slow method. The correct shape of the cleats should be drawn on the floor on the top of the elevation when the timber can be placed on top lines squared-up and the height marked. Joining the points with a steel rule so as to get a curve is a simple matter.



FIGS. 7, 8, 9 AND 10—RUDDER PATTERN IN COURSE OF CONSTRUCTION FIGS. 11 AND 12 ARE TOP AND BOTTOM VIEWS

Making the Layout

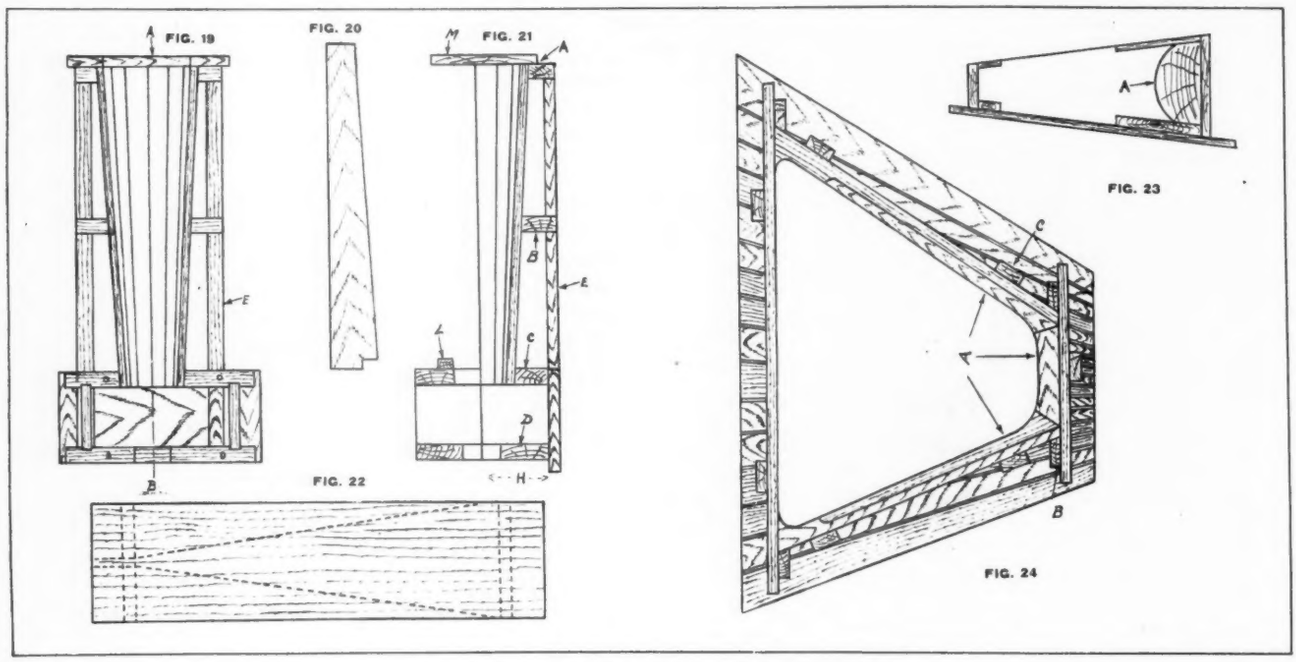
Fig. 17 shows the rudder outline and the lines *AB*, *CD* and *EFH* represent the shapes on the lines *AL*, *KD* and *EH*, respectively. Let us suppose that we want to define the shape on the diagonal line *PH*. At the point *R*, where the perpendicular line intercepts the diagonal, line *TR* is drawn square to *LO*. With *R* as a center and *RT* as a radius, describe an arc and draw the line *RK* square to *PH*. The intersection of the arc with the square line gives the correct height of the diagonal line at *R*. The heights at the other points are obtained similarly. A number of lines parallel to *AE* must now be drawn. It is customary in practice to number those lines and it saves confusion, when transferring the sizes to the timber, the same numbers being used on the squared lines. With

L as a center and *LB* as a radius, describe the arc and with *O* as a center and *OF* as a radius describe another arc. The points *MN*, where those arc intersect *AL* and *EH* are now joined.

When the core dividing ribs have been marked-off they will have to be checked where they cross each other. It is better to keep them long and check them than to carry one through and make a butt joint of the other. The joint frame depends upon these ribs to keep it true. When the ribs are screwed in their correct positions the boss will have to be fixed. It will be necessary to slot the cleats so that the boss will bed onto the frames, and it may be advisable to reduce that portion of the ribs within the boss so that too great a depth will not have to be cut out of the cleats, thereby unduly weakening them. The print at *A* also will have to be fitted over the ribs.

It is now necessary to screw strips against the ribs just sufficiently wide to support the prints. Timber, about 1 inch thick, will suffice and to prevent the danger of the prints being knocked in when the mold is being rammed, distance pieces may be fitted between the strips and the joint plate. In order to avoid getting an irregular surface, it is better to leave the print supporting strips just above the ribs so that the whole surface can be planed, the print *A* being temporarily removed to permit of this being done. To get the correct shape of the prints, which need only be about ¾-inch thick, it is advisable to set out the shapes on the pattern, lifting the sizes from the floor drawing. Strips of timber, about 3 inches wide, can now be fitted, mitered, and cut to shape. The print strips that are running diagonally will have to be made from thick timber and after they are bedded down, they can be gagged to a parallel thickness without difficulty.

The easiest way of bedding them to the pattern face is to support them on two blocks resting on the pattern face and to gage a parallel line. If care is taken very little fitting will be needed. There is still a thin strip, usually ¼-inch thick, to be put round the pattern faces. It is shown at *A*, Figs. 3 ,4, 5 and 6. Rudders are balanced with spruce filling and the plating which covers the whole face is kept in position by means of this strip. When the end print, *E*, Figs. 9 and 10, is screwed on, the pattern is finished. This print should be about 3 inches thick to give a fair bearing for the core. A view of the finished pattern looking on the top of the boss is shown in Fig. 11, and a view looking on the bottom is shown in Fig. 12.



FIGS. 19 TO 24—DETAILS OF CORE BOX CONSTRUCTION

Making the Core Boxes

The core boxes involve a considerable amount of labor. It may be mentioned that the core of the boss is usually rough-turned at the foundry, but sufficient is left for a finishing cut. The reason for this is to insure sound metal in the boss. Figs. 19, 20 and 21 illustrate the core box for the boss, Fig. 19 being a plan with the top half of the square box removed and Fig. 20 is a section on the line *AB*, Fig. 19. The view, Fig. 16, can be again used for getting out the cleats, *A*, *B*, *C* and *D*, Fig. 21. These cleats should be at least 2 inches thick. The box will be built on two bottom stays, *E*, which are checked the full thickness into the cleats *A* and *B*. The width of all the cleats is determined by the depth *A*, Fig. 21. Before building the staves onto the cleats it is advisable to put the checks in cleats *C* for the ends of the square box. It is much easier to cut these slots on a band or a dimension saw than to cut them with a chisel when the box is half made. After the staves have been screwed in place and the top edges planed off flush with the cleats, the square end can be completed. It is just an ordinary framed box. It must of course be made in two, because of the circular holes in the sides, and the top will have to be doweled to bottom.

A full core box might have been made for the whole box, but it is preferable to sweep the top half of the circular core. It simplifies the molder's task when filling and it is easier for him to make a grid. From the pattern shop point of view also it is much cheaper. The sweep necessary is shown in Fig. 20. Some arrangement is necessary to guide the sweep. If it were a parallel core, a side guide and a semicircular sweep would be the best way for the coremaker, but it is a tapered core so there is practically no alternative to a long board. Segments *L*, Fig. 2, should be screwed to the outside of the square box at one end and a cleat, *M*, screwed at the outside of the box at the other end. The sweep will ride on these. When making the bottom cleats and staves for this box the strongest job is obtained by checking the stays into all the cleats alike. This, however, necessitates making the bottom pieces the same thick-

ness as the stays, and consequently very heavy.

As the method of constructing the five lightening core boxes is the same, it will be sufficient to describe one. All these core boxes should have bottoms. It is a great convenience to a molder to have a bottom on a core box. It may cheapen the patternmaking a little not to trouble about bottoms, but the cost of making a bed in the foundry is greater. Fig. 23 shows a section of the topmost box on the line, *EF*, Fig. 1. It differs from the others in having a block, *A*, to complete the diameter of the box, otherwise the center core would break through. In getting out these boxes, the bottom should be made first. It will be noted from Fig. 24 that the bottoms are open-jointed and all the pieces are tapered. This is better for battening than marking it of parallel widths. The sides of the box might the drawn off before being screwed together, but considerable difficulty may be experienced in getting the box accurate when screwing it together. A more effective way is to make all the sides the width of the deepest point of the box, Fig. 22. This permits the box to be tested on the drawing, and if correct, it is a simple matter to unscrew it, cut the sides to the correct shape and put it together again. The depth of the box at the various points may be found by caliper, but if the pattern has been accurately made the depth can be found geometrically in the same way as the dividing ribs for the bottom half of the pattern. The pieces, *A*, Fig. 23, form the ribs in the top and bottom of the box and the top pieces will have to be loosened by the coremaker. It will be noted that instead of checking, the side the bars *B*, Fig. 24, keep the sides in correct relation to each other. As the coremaker will have to loosen the sides and draw them away from the core, they should not be screwed from the underside, but should be held by means of blocks or buttons, *C*, Fig. 24. These blocks may be 4 or 5 inches long.

Alternative Method of Making Pattern

We shall now consider the alternative method of making the pattern, that is, a pattern which is almost a replica of the casting. The patternmaker's guiding thought throughout the job must be to get the greatest strength possible, and it is difficult to make such a fragile piece of work strongly. Two plates, *A*, Fig. 26, will have to be made on which the boss will rest. Because of its shape, it is not advisable to make an open frame, as it would not be as strong as a plate. The battens, *B*, ought to be let into the plate half the thickness and if it can be obtained, hardwood such as baywood, teak, sycamore or maple, should be used. The boss for each half will of course be a semidiameter less the thickness of this joint plate. After the boss is screwed to the plate, it will be well to place it on the working drawing and build a frame against it to support the ribs that separate the cores. This is a delicate job. It will be readily seen that if the ribs were laid on the floor the full depth it would be difficult to joint them so that when the pattern is lifted the whole work would be rigid. It is better to build two thicknesses of ¼-inch timber, well jointed and screwed.

Fig. 25 is a view showing the plate with the boss removed, and the skeleton-like construction with the joint arranged so as to give the greatest possible strength.

Fig. 26 shows the finished pattern. It will be noted that the boss is carried through to the outside, but it is really better to keep it back the thickness of the rib *A*, so that this rib will help to bind the framework better by crossing the plate, being screwed to the face of the boss. As will be seen from Fig. 26, the ribs are jointed across each other over the bottom plate. The necessity for this is obvious, as it is the chief means of binding the boss portion of the pattern to the outer skeleton. It will be advisable to make the square shape at the foot of the boss. Solid blocks should be carefully fitted-in, glued and screwed. The top print has been left off to show the construction. The fillets, *C*, which should also be carefully fitted, help to keep the ribs rigid. All that remains to be done is to make and screw into position the ribs *D*. If the work is in a great hurry it is possible to make the two halves at the same time and dowel them afterwards, but generally it is wiser to complete the construction of one-half, although of course the pieces may all be finished at the same time before the other half is commenced. The completed portion can be turned over and the other half built on top of it. If the foundry is a considerable distance from the pattern shop, it is wise to screw some edge bars across the pattern. The molder can remove them before he is ready to start his work.

(*Concluded on page* 259)

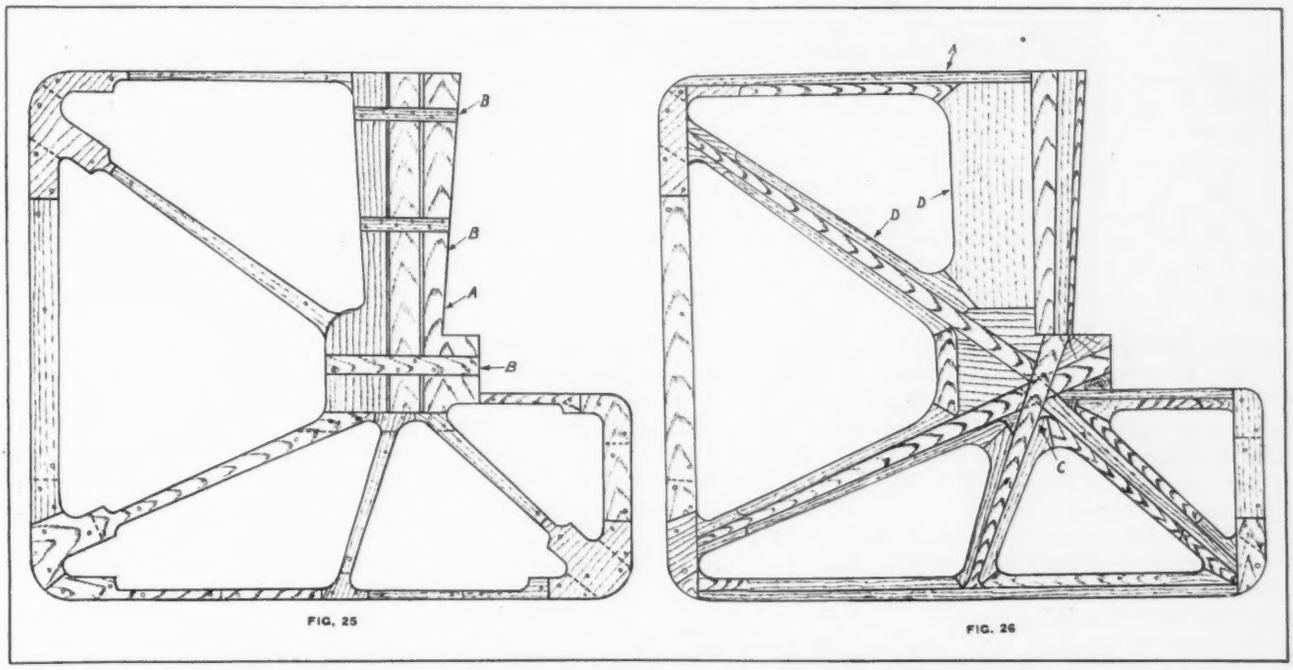
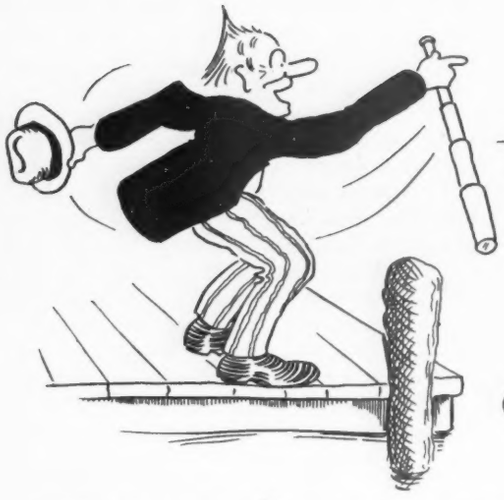


FIG. 25—SKELETON RUDDER PATTERN UNDER CONSTRUCTION AND FIG. 26 IS THE FINISHED PATTERN



Bill Learns About the Hardy Argonauts

By Pat Dwyer

"SAY," said Bill to me one day, "did you ever hear of that hardy bunch of young devils called 'The Argonauts'?" "Which bunch do you mean?" I asked. "Is it the aquatic club in Toronto; or do you refer to the original, first and only genuine Argonauts, who sailed away with Capt. Henry M. Jason in his search for the golden fleece?"

"I mean the original gang," said Bill, "the big league fellows from Ithaca, N. Y. It must have been a long time ago. I have followed the baseball dope pretty close for a good many years, and I never remembered hearing of a big league club in Ithaca."

"Oh!" I said, "you are all tangled up. They were not a base ball club, and while it is true they hailed from Ithaca, it was not Ithaca, N. Y."

"Well, to tell you the truth," said Bill, "I was not paying much attention. It was like this. One of my little girls was reading over this story out of her reader one night. I was reading the paper at the time and did not pay any attention to what she was saying, until she was about half way through. This apparent indifference naturally peeved the young lady. So she came over, pushed my paper out of the way and perched herself on my knee. 'Now, Paw,' said she, 'pay attention.' Being a willing and well-trained father, I curled one arm around her, and believe me, I followed the rest of the adventures of that crowd right close. They were some birds, all right. It is a wonder some enterprising movie man has not made a film of the thing." "Yes," I said, "it is fairly good story with lots of action in it. When you come to examine it, though, you will find that although it was written a couple of thousand years ago, it is the same old theme that novelists have built their romances on ever since. It has a hero, a heroine and a cruel old father, who thought no one was good enough for his beautiful daughter. An ordinary parent would have said 'No' in a loud voice, and if the young man persisted in tagging around, would have set the dog on him or tried a pot shot with an old blunderbuss. But that way would not do for a king. So he gave the hero a seemingly impossible task and told him, right friendly, that he thought a lot of him and if he did him this little favor, why—he could have the girl, to have and to hold, until she was tired of him—or words to that effect."

"It is a pity," said Bill, "that the old gaffer did not own a foundry. Then he could have offered the hero charge of it; given him about 50 green helpers, no pig iron and a couple of cars of high sulphur coke, and told him he expected him to turn out about 100 tons of good, soft, machinable castings a day. I suppose, though, with his usual luck, the hero would have discovered on the beach a large stranded steamer, loaded with molding machines and other foundry equipment, including a generous supply of ferromanganese and ferrosilicon. Standing guard at the main hatch he would have found a beautiful creature, who would have put him wise to the nature and virtue of those things, and when he turned in his report at the end of the month, I guess the old man would have pinned a medal on him and called off all the other stunts he had in mind. He might even have taken him into partnership and made him assistant king, or something like that."

"I guess you are about right," I said, "the king's job was a pretty soft thing in those days, but I don't think it is such a cinch now. What I like about those Argonaut fellows is their spirit of daring and willingness to break away from established precedent. They went through all kinds of hardship, endured all kinds of temptation and danger, fatigue, cold and hunger. They were no strangers to battle, murder and sudden death. In spite of it all, they plugged along, gritted their teeth, tightened their belts at each reverse, and finally, which is not the fortune of every Argonaut they brought home the golden fleece. "It may

AND BILL DID

be only fiction, I don't know; for many queer things took place in those far-off ancient days. But one thing I do know and that is the same spirit which actuated those adventurers is still alive, and a sorry world it would be if it were to die out."

"What's the idea," said Bill, "the war is over and you are only wasting your time, and mine, pulling that old recruiting stuff."

"Recruit nothing," I said. "Soldiering is not the only trade that produces heroes. If you had as much politness as you have gab, you would not come butting in just as I was getting a fair start."

"ALL RIGHT," SAID BILL, "TALK AWAY"

"All right," said Bill, "talk away. But talk about something I know. Talk about the foundry."

"That was just what I was coming to," I said.

"I was going to point out to you that none of the arts, sciences, discoveries and improvements in every walk of life, would have come into existence if this daring spirit of the old Argonauts were not still alive. You may talk all you like about kings, queens, iron dukes and iron chancellors making history, but you take it from me, the real makers of history have been the pioneers. These were not only the men who gallantly fared forth into strange lands and among strange people, taking their lives in their hands and all their worldly goods in a red handkerchief slung over their shoulders, but the men who broke away from precedent and tradition, and tried new ways and new methods of doing things. When the final history is written and the prizes are distributed, I bet you will find a medal or two pinned on the undershirt of the iron melter and the iron molder."

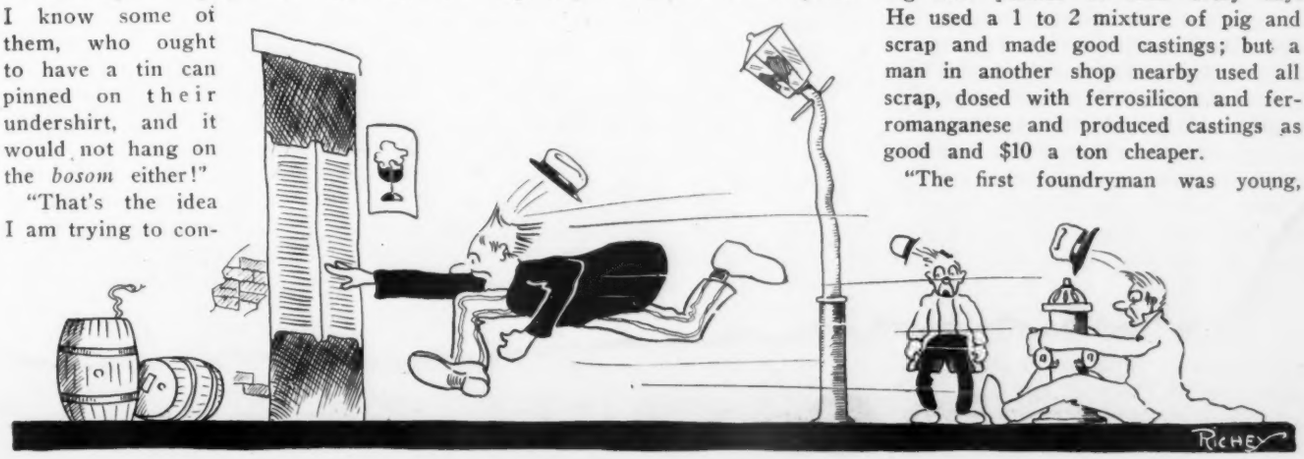
"You may be right," said Bill, "but I know some of them, who ought to have a tin can pinned on their undershirt, and it would not hang on the *bosom* either!"

"That's the idea I am trying to convey to you without losing my temper," I said. "All men are not Argonauts, or pioneers, or heroes. There are just enough of them sprinkled among the population to keep the old pot boiling. The worst of it is, that their efforts are seldom appreciated. The standpatters, those who cling to precedent, are so overwhelmingly in the majority, that the pioneers generally have a thankless and weary journey through life. The fact that their ideas and processes are eventually adopted does not do them much good, for by that time they are probably skilled performers on the harp and don't care a B flat what the people on the earth are doing.

"I don't pretend to know anything of laundries, dye works, bakeries, boot and shoe shops, the textile industry, or how buttons are made, or any of the other thousand-and-one phases of industrial life; but it is my firm conviction that the foundry business has them all trimmed when it comes to clinging to precedent. There are, of course, hundreds of shops in this country right up to the minute; but there are about 7000 shops in North America and I bet 6000 of them are running the way they did 20, 30 or 50 years ago. They are judging iron by fracture instead of analysis; making-up charges by-guess and by-gosh, using a 1000-pound charge when the furnace could easily carry 2000 pounds; breaking all the iron into small pieces when they could just as well dump it on body and bones; using small fans and running a heat two hours when a big healthy fan would bring the iron down in an hour; using antiquated rigging and patterns that Noah threw away when he finished the ark; dumping a couple of barrows of new sand in every heap every day; and following a hundred-and-one other time-wasting and money-wasting processes. Mind you, I don't say that you will find all these ideas in vogue in any one shop. Some are better, some worse. Putting it on a percentage basis I would say, off-hand, that there are few shops 100 per cent efficient. There are some about 90 per cent, and a good many about 75 per cent; but the great majority are only about 50 per cent. The funny thing about it is that they all think they are operating at 100 per cent efficiency and you can't persuade them otherwise.

"Laying aside generalities and coming to concrete cases I will tell you of two instances. One man with a 60-inch cupola, used a 5000-pound charge with 700 pounds of coke in between, when he might just as well have used 6000 pounds with 600 pounds of coke. That meant, on a 50-ton heat, that he wasted over a ton of coke every day. Besides that, for some unknown reason, he always placed a full charge of coke *on top* of the last charge of iron, wasting 2800 pounds of coke every day. He used a 1 to 2 mixture of pig and scrap and made good castings; but a man in another shop nearby used all scrap, dosed with ferrosilicon and ferromanganese and produced castings as good and $10 a ton cheaper.

"The first foundryman was young,



HE EASED THROUGH A PAIR OF SWINGING DOORS

and a strict martinet. He was strong on organization and required the last ounce of labor from his men. His labor cost sheet was the best I ever saw.

"The other man was old and easy going. His labor cost sheet was something cruel; so that in the end their total costs per ton were about the same. Now if the young man had the older foundryman's knowledge, or if the older man had the other's genius for organizing and gift for getting the highest production out of his men, it would mean a difference of $500 a day in operating either shop. That would be quite a fleece, golden or otherwise, at the present price of wool. Being a strong believer in the Argonaut policy myself, I once suggested to the first man that he adopt the other's furnace practice. He pooh-poohed the idea. 'I don't think that old gaffer can teach me anything,' he said, 'I am getting out the same tonnage as he is with about half the number of men, and that argument ought to convince you as to who is the better man.'

"When I suggested to the older foundryman that he adopt the other's labor policy, he also ridiculed the idea. 'You can't drive men and get good work,' said he. 'I save enough on my furnace practice to offset the difference in labor cost. So why should I worry?'

"The leaven is working, though, slowly but surely. The Argonauts are experimenting and improving things here and there; some in one line, some in another. They have prejudice and tradition to contend with, but every year foundrymen are getting closer together. There is a more frequent comparison of ways and means, and frequently, in spite of themselves, foundrymen are becoming convinced that like Jason of old, if they had avoided the sirens of Lemnos in the shape of other people's set opinions, if they had avoided the twin rocks of the Symplegades in the shape of prejudice and tradition and adopted a straight, common-sense course with all modern conveniences to help them, they could have grabbed the golden fleece long ago."

"All right," said Bill, "I won't start an argument with you: let's knock off and call it a day. If there is anything I hate it is one of these here one-sided conversations where the other fellow does all the talking. I don't know if talking makes you dry, but I know that listening affects me that way."

The last I saw of Bill he was easing himself through a pair of those swinging half-length doors which you never see in Kansas, nor Michigan nowadays.

How Phosphorus Affects Malleable Castings

AN article entitled "Effects of Phosphorus on Malleable Cast Iron," by J. H. Teng, which was published in THE FOUNDRY, April 1, has attracted considerable attention and a number of communications discussing various features of this contribution have been received by the editor. Some of these letters bring out points of special interest to foundrymen, and various opinions regarding the effect of phosphorus are expressed. The following, which was received from P. H. Davis, general superintendent, Moline Malleable Iron Co., St. Charles, Ill., presents one point of view:

"I have read with a good deal of interest the article by J. H. Teng in your April 1 issue on the effects of phosphorus on malleable castings. I note that the summary proves what many of us have for years known to be a fact.

"You will note that Dr. Richard Moldenke and Prof. Enrique Touceda are quoted as making conflicting statements in regard to the amount of phosphorus which may be permitted in iron for malleable castings. You also will find by referring to the paper read at the Atlantic City convention of the American Foundrymen's association in 1915, that Professor Touceda claims that the effect of phosphorus upon the iron is not as great as has been thought, yet in the experiments he disproves his own statement. By referring to Table I on page 448 of THE FOUNDRY, November, 1915, you will find it stated with reference to certain test bars, that:

Set No. 1 contains 0.181 per cent phosphorus
Set No. 2 contains 0.252 per cent phosphorus
Set No. 3 contains 0.325 per cent phosphorus
Set No. 4 contains 0.388 per cent phosphorus

while on the same page you will note that:

Bar No. 1 (with the lowest phosphorus content) broke at 22 blows, thus establishing the standard.
Bar No. 2 broke at 20 blows or about 10 per cent less than No. 1 or the standard.
Bar No. 3 broke at 15 blows or about 33 1-3 per cent less than bar No. 1.
Bar No. 4 broke at 5 blows or practically 75 per cent under No. 1.

"This to my mind shows that Professor Touceda's statements were not upheld and that the British experiment corroborates the actual outcome of the addition of phosphorus to the iron."

Not Black-Heart Iron

In order that Professor Touceda might have an opportunity to comment on the apparent discrepancy between the results of tests given in the two papers, Mr. Davis' letter was forwarded to him. In reply the following communication was received from Professor Touceda:

"In a hasty review of Mr. Teng's paper, several facts stand out conspicuously. In Table III, covering chemical and physical data, on a series of tensile test bars in which the phosphorus increases from 0.01 per cent in the first to 0.508 per cent in the eleventh, we find that the silicon in all of them is about 0.20 per cent while the manganese is nil. Further remarks in connection with these tests should not be needed, because the effect of phosphorus on bars of an impossible composition for the production of black-heart malleable iron cannot properly be compared with similar tests made on that product.

Actually, Mr. Davis is comparing the results of experiments made on the annealing of hard-iron test bars from which black-heart malleable iron could not successfully be made with experiments made on those of appropriate composition to yield a good material.

"That the physical properties of the bars shown in Table III are inferior can be seen from an inspection of the figures. Imagine drawing conclusions from tests on bars the best of which shows an elongation of but 3.8 per cent.

"In Table IV, which Mr. Teng calls the 'Common Iron Series,' the physical tests show the material also to be inferior, though slightly better than in the case of Table III. In these, the lowest sulphur content is 0.244 per cent. Again I feel I must ask, why compare experiments made on metal like this with those made on black-heart malleable iron of good quality?

"No one will question the fact that the ill effects of phosphorus are exaggerated by the presence of combined carbon. It was owing to the fact that black-heart malleable iron rarely runs over a trace of combined carbon, that the writer anticipated that greater liberties might be taken with phosphorus in this grade of malleable than was popularly supposed.

"If the facts are correctly stated in the footnote under Table III, as to the manner in which the drillings were secured for analysis, Mr. Teng's carbon determinations are wrong, and this is particularly true in connection with the combined carbon. As high as they are reported, it is the writer's belief that a correct sampling would prove that they are higher than recorded. If the combined carbon has

the influence referred to, why compare tests made on a material high in that element with one that contains hardly any?

"Both Mr. Davis and Mr. Teng refer to the tests I made on samples containing 0.325 per cent phosphorus, so it might be well for comparison to confine our attention to the eight bars in each table of Mr. Teng's article that were under and a little higher in phosphorus than that figure.

"Mr. Teng should be informed that in this country we measure the quality of our malleable iron by the combined ultimate strength and elongation. If we were willing to make a great sacrifice in ductility, by which I mean run on an elongation as low as 6 per cent, which is considerably higher than any he records, we could easily obtain an ultimate strength of 75,000 pounds per square inch.

"Based upon elongation, the eight bars referred to in Table III, can be characterized from our point of view as worthless material. The same remark holds true in connection with the ultimate strength, when coupled with the elongation.

"The figures show that an increase in phosphorus content from 0.01 per cent to 0.345 per cent, a limit considerably higher than used by the writer, resulted in a lowering of the ultimate strength from 45,700 to 42,300 pounds per square inch and the elongation from 3.8 per cent to 2.5 per cent. I make no mention of the reduction of area for when it is this low it can hardly be accurately measured on a rough cast bar, presumably not perfectly round.

"In Table IV, the eight bars run between the limits of 0.048 per cent and 0.346 per cent phosphorus, with an ultimate strength in the first bar of 50,400 pounds per square inch to 47,300 pounds in the eighth, and an elongation of 4.5 per cent as against 3.4 per cent.

"Now it is common knowledge that as far as elongation and ultimate strength are concerned, a difference as great as this is quite frequently found in test bars cast in the same mold.

"As a matter of fact, the most unique feature of Mr. Teng's paper, to me, is the uniformly gradual decrease in the physical properties as shown by him. When one considers that he is dealing with a cast material and not a worked one, and the many variables that enter into a product that is cast, the results seem unusually uniform.

"In Table III, a lowering of the phosphorus from 0.345 per cent to a trace, resulted, as far as ductility is concerned—it is this property that phosphorus is supposed to influence most—in a gain in elongation of only 1.3 per cent actual.

"In Table IV, a lowering of the phosphorus from 0.346 per cent down to 0.048 per cent caused a gain in the elongation of only 1.1 per cent actual. Can this be characterized as a startling improvement?

Former Article Quoted

"Here is what the writer states in his paper before the American Foundrymen's association, published in THE FOUNDRY, November, 1915, and to which both Mr. Teng and Mr. Davis refer:

"'From a consideration of the facts before us, it would appear that when the amount of combined carbon is very low, the evil effects of phosphorus are slow to make themselves felt, and it requires a substantial increase in this element before a corresponding change in physical characteristics can be noticed.'

"Based upon Mr. Teng's findings it would appear to the writer that he could use the same phraseology; substituting for the words 'when the combined carbon is very low' the words 'when the combined carbon is even quite high.'

"Now in connection with the remarks made by Mr. Davis, let us see exactly what I stated in reference to the particular tests he has quoted. The full quotation is, 'The ⅞-inch square test bars, previously referred to, were cast at the same time and made of the same metal as the four sets of wedges, and to test these transversely they were placed on the anvil of the same hammer, on supports 6 inches apart. The following is a record of the number of 70 foot-pound blows required to break them:

Bar No.	No. of Blows
1	22
2	20
3	15
4	5

"'From these figures it would appear that as the section is increased, the evil effects of phosphorus become more manifest. However, bar No. 3 was subjected to fifteen 70 foot-pound blows before rupture took place, which for a metal containing 0.325 per cent of phosphorus, or about 1.95 per cent of phosphide of iron, is certainly no mean test. Bar No. 2, containing 0.252 per cent of phosphorus, or about 1.51 per cent of phosphide of iron, required 20 blows to produce failure, a test which I consider indicates superior metal.'"

Book Review

Storage—by H. B. Twyford, Otis Elevator Co.; cloth, 200 pp., 6 x 9 inches; published by D. Van Nostrand Co., New York; furnished by THE FOUNDRY for $3.50 net.

Storing raw and manufactured articles forms a line of economic endeavor, which has not been appreciated to its fullest extent. Lack of proper storing constitutes a handicap to any business, and more especially to a manufacturing enterprise. Last winter's transportation difficulties focused attention upon the danger of limited capacity for storing. Post-armistice cancellations emphasized the folly of unlimited hoarding of supplies and manufactured articles. These two extreme instances serve to demonstrate the problem as one worthy of study by the executive. The first portion of this book is devoted to a discussion of the economic aspects of the storage problem. Stored material is considered as a source of wealth, capable of appreciation in value only through an advance in price, but subject to loss through storing cost, and a number of depreciation factors. Details relating to the best modern storage practice occupy the remaining portions of the book. Emphasis is placed upon the correct description, records and inventory as essential to economical storing. Location, equipment and storeroom appliances as factors in decreasing cost, occupy a number of chapters which are well illustrated from photographs. Inspection, receiving and delivery are discussed. Ledger, card and memoranda forms are suggested for these details of storing. The author handles the entire question as a problem in business procedure and his discussion is in the character of a summation of modern experience.

Making Castings Used in Ship Construction

(*Concluded from page* 255)

There are so many loose pieces of ribs on the pattern that it will save a great deal of trouble, when the pattern has to be screwed together again, to mark them carefully. Some pattern shops are content with lettering loose pieces, but the pressed letters soon swell and cannot be seen, and paint marks are also soon obliterated. A good chisel cut or a V-tool mark is easily seen and will remain distinct as long as the pattern can be used.

The Hart-Parr Co., Charles City, Iowa, will finish its steel truck wheel contract with the government during the latter part of April. The manufacture of wheels and miscellaneous steel castings is contemplated.

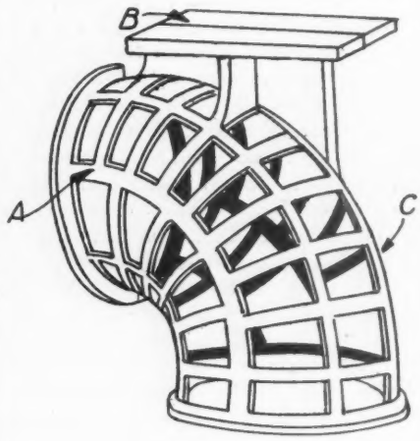


FIG. 1

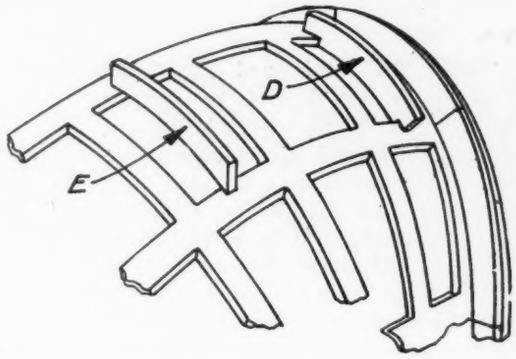


FIG. 3

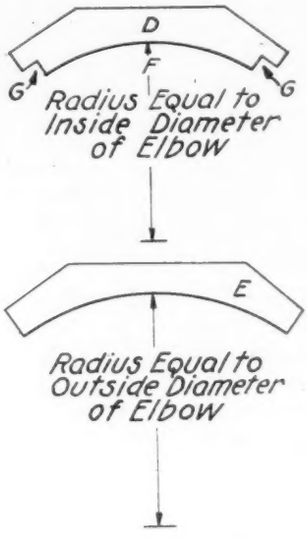


FIG. 2

FIG. 1—COMPLETE PATTERN FOR THE ELBOW, SHOWING THE SPECIAL FLANGE AND BASE FIG. 2—INSIDE AND OUTSIDE SWEEPS, D AND E FOR FORMING THE SAND MOLD AND CORE FIG. 3—ILLUSTRATING THE USE OF THE SWEEPS WITH THE SKELETON PATTERN

FIG. 4—FOUNDATION PLATE AND CRAB IRON, SHOWING THE TWO RAILS USED IN THE BASE FIG. 5—DESIGN OF CRAB IRON USED, SHOWING THE SPIKED PORTION FIG. 6—SECTION OF CORE INDICATING THE MANNER OF BUILDING THE BRICKWORK AND PLACING THE CRAB IRON

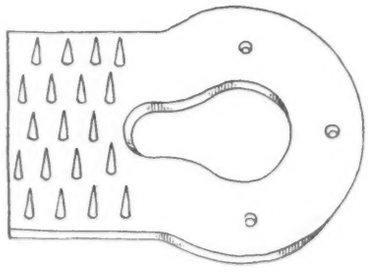


FIG. 5

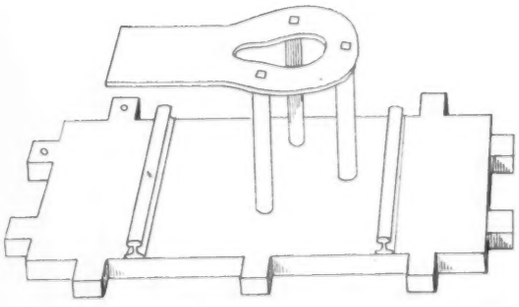


FIG. 4

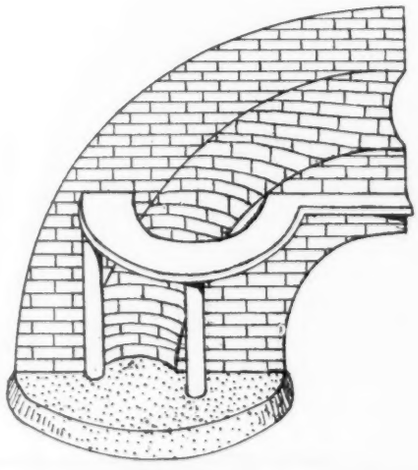


FIG. 6

Making a Skelton Pattern for a Large Elbow and Base

By B Rupert Hall

WHEN a breakdown order accompanied by the word "rush" is received by the pattern department of any foundry it puts the patternmaker foreman on his mettle. In many cases, where a duplicate part is wanted, the casting itself may be transformed into a pattern. Where this is impossible, a skeleton pattern may be used to best advantage.

Skeleton patterns are employed to reduce the pattern cost to a minimum. They are unlimited in scope and are applicable to either green sand, dry sand or loam molding. The determining factor controlling the use of the skeleton pattern is its durability and the probable number of castings required.

Making an Elbow Pattern

There are many instances where the pattern is large and portions of it are peculiarly formed. In these the skeleton method may be used to mold the odd shape in conjunction with a regularly constructed simple pattern. This reduces the cost and greatly facilitates the molding and coring processes. Furthermore, skeleton patterns enable the molder to form a peculiarly shaped core which would otherwise necessitate a complicated core box. This saves considerable expense.

To illustrate this method a skeleton pattern for a large elbow having a foot base will be described. In the case in point one casting was all that was required. It was not anticipated that the pattern would again be used, so the cheapest practicable method was employed to produce the mold.

The casting is shown at the head of this page. In Fig. 1 the skeleton pattern and foot base section pattern *B* is shown attached. The general construction of the skeleton is shown with the exception of the joints which were halved into the four main supports of the flanges. Only one of the supports is here shown at *A*, Fig. 1. The flange in this case was built of two rows of segments as it was a temporary piece of work. For permanent work three courses are always recommended to obviate distortion due to the shrinkage of stock. The skeleton and section pattern were made in halves being parted along the line *C* Fig. 1. During the process of building-up the loam work of the elbow, the section pattern of the foot base *B* was removed. Two sweeps were required. If the pattern had been used to make a mold by the bedding-in process, four sweeps would have been needed. The two sweeps here required are shown in Fig. 2, *D* and *E*. Sweep *D* had a notch *G* cut in the two ends. The curvature of this sweep was made to the radius *F* of the inside of the pipe or the size of the core. When using the sweep the notch *G* on each end of the sweep *D* followed and was supported on the ribs of the skeleton as indicated in Fig. 3, sweeping the core to form as shown within the skeleton in Fig. 7. The sweep *E*, Fig. 2, was used to sweep the outside of the skeleton. The radius of this sweep conformed to the diameter of the outside of the elbow producing the surface flush with the outer contour of the skeleton as shown in Fig. 7.

The molding process which was adopted was interesting. A cast iron foundation plate shown in Fig. 4, of ample thickness, length and width was obtained. The size of the plate was made to allow about 12 inches margin all around. The mold for this plate was made in open sand having the form as shown in Fig. 4. The 1-inch holes were to receive the bolts used to hold the mold together. A sand bed on the floor was leveled, the bolts put in place and the plate leveled and bedded down. A layer of sand was spread over the plate and a single course of brick laid. Two T-rails, shown in Fig. 4, were laid on this plate to support the parts of the mold that had to be removed after the mold was completed. The crab iron shown in Fig. 5 was set in place as indicated in Fig. 4, being supported on three uprights. These uprights were made of 2-inch pipe placed over the bolts and with the spiked pricker plate bolted to them. When these were all in place the building of the core was begun.

A layer of heap sand was spread over the plate, bricks were laid upon this and then strong sand was spread and rammed to come up even with the top of the T-rails. This bed was swept smooth. An elevated portion then was swept as shown in Fig. 7, having beveled sides, *I*. The skeleton next was placed in position around the crab iron and a brick backing was built up inside the skeleton to the under side of the crab iron. The brick was kept about ¼-inch away from the skeleton pattern to allow the loam to be placed around the built-up brickwork. This loam was placed and formed with the sweep *D*, Fig. 2. The spiked portion of the crab iron was daubed with loam and swept off.

Building Up the Core

The building of the core was then continued on the top of the crab iron and carried up until about two-thirds of the distance from the top of the core where another crab iron *P*, Fig. 7 was set in place. The purpose of this second crab iron was to hold the sand on the upper part of the core and to prevent the core from floating when the metal was poured. Loam was next filled in and swept off, making a smooth surface even with the inside of the frame. Common sand was then placed between the ribs, packed solid and brought to an even contour with the sweep *E*. Fig. 2.

A parting material was used on this surface and a thickness of loam applied to it. Brickwork was built up as the loam work proceeded, making a parting of the mold to correspond to the part-

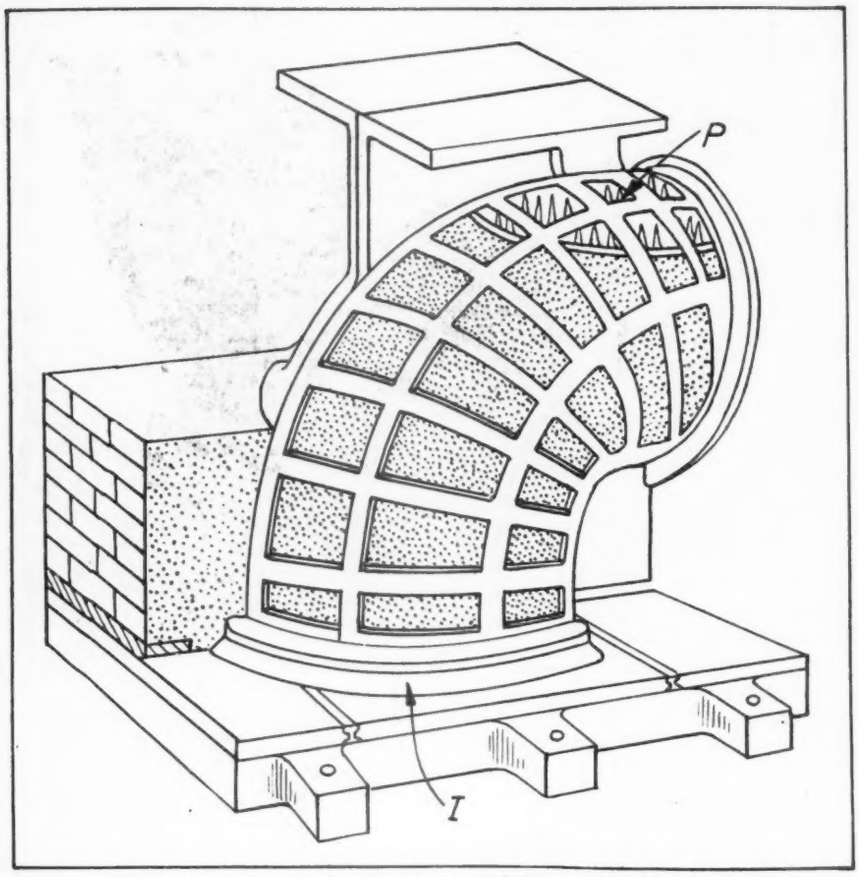


FIG. 7—PATTERN IN PLACE ON FOUNDATION PLATE WITH CORE SWEPT INSIDE AND PART OF THE OUTER SURFACE COMPLETED—A SECTION OF THE BRICKWORK OF THE MOLD IS IN PLACE

ing of the pattern. Partings also were made between the foundation plate and the outside portion of the mold. In some cases it would have been advisable to make the outside of the mold in sections. In Fig. 6 a section of the core is shown with the crab iron in position. It should be noted that the core was constructed to insure crushing through contraction in cooling.

Melting in a Small Cupola Without Slagging

By G. R. Brandon

Question:—How should we charge a cupola lined to 30 inches and how many pounds of coke should be placed on the bed The cupola is equipped with one row of tuyeres and we would like to know how many pounds of iron it will melt without slagging? How much limestone should be charged for fluxing? The four tuyeres are located 18 inches above the bottom, each 3½ x 4 inches. Also, we have a cupola lined to 42 inches which has six tuyere openings, each 4 inches high and 5 inches wide. While we did not intend to use this cupola, we have been wondering whether a 4-inch brick lining, reducing the inside diameter to 32 inches, would give us better results than melting in the 30-inch cupola?

Answer:—For a cupola 30 inches in diameter inside of the lining, we recommend 550 pounds of coke on the bed, or a sufficient quantity to bring the bed of coke about 18 inches above the level of the tuyere opening; 1400 pounds of iron should be charged on the bed to be followed by 90 to 100 pounds of coke in the succeeding charges and 900 pounds of iron. Your blower should deliver about 2250 cubic feet of air per minute and should operate at a speed of 300 revolutions per minute. The present standard blower of this type has a 12-inch diameter discharge, but probably a 10-inch discharge will be suitable for your conditions. A gate in the blast pipe is advisable for emergencies. Always close the gate if for any reason it becomes necessary to stop the blower to prevent gases from the cupola entering the blower case. With a positive blower it is not good practice to use the blast gate to decrease the supply of air to the cupola as the power for operating the blower is thereby increased. For this reason it will be preferable to provide some means for reducing the blower speed. Also, it is unnecessary when deriving blast from a blower to close the gate toward the end of the heat which is the case when the blast is being furnished by the fan.

The amount of iron that may be melted without slagging depends upon the iron, whether sand or chill cast; the scrap, whether heavily rusted or not and also upon the amount of coke used. With coke containing 10 to 12 per cent ash and with careful charging, exercising care to have charges of uniform thickness and of equal density throughout the height of the cupola, you should be able to run down about 5 tons without slagging. Limestone should be used for fluxing in the proportion of 20 to 30 pounds of coke of good quality. The amount of limestone, however, must be increased in proportion to the increase of ash in the coke. Oyster shells may be used in the place of limestone, both being carbonate of lime suitable for use.

Manganese in the form of ferromanganese is not used for fluxing purposes, but to increase the percentage of manganese in the molten metal; 40 per cent of No. 2 foundry iron and 60 per cent of machinery scrap would be a good mixture for your purpose. The flux should be added to the second or third charge above the bed. The flux has no effect on the quality of the iron mixture.

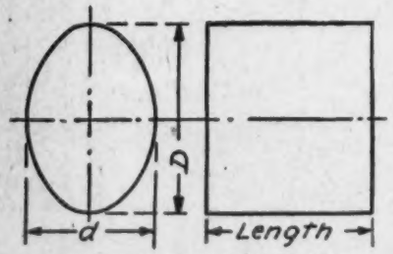
The height of the tuyere, namely 18 inches above the bottom, is correct. The area of the tuyere openings in the shell should be about three times the present area and preferably the tuyere should be of greater width at the inside of the lining. By flaring the tuyeres on the inside, the tuyere area is increased and the blast softened, while the distribution of the blast is more uniform. The air chamber, 8 x 8 inches in size, is satisfactory, if the blast is admitted in such a manner that it will travel in both directions with equal facility. No advantage would be derived from using the large cupola for the smaller output required. The 30-inch cupola will melt from 2 to 3 tons per hour. In our opinion the tuyeres with which the larger cupola is equipped are not of sufficient area to furnish the blast required.

New Furnaces Installed

Holcroft & Co., Detroit, recently have completed the installation of the following ovens and furnaces: Twelve core ovens for the Nash Motors Co., Kenosha, Wis.; 15 at the International Harvester Tractor plant, Chicago; 32 for Central Foundry Co., division of the General Motors Co., Saginaw, Mich.; two batteries core ovens and 14 annealing furnaces at the Saginaw Malleable Iron Co.; batteries of ovens for Atlas Foundry Co. and D. J. Ryan Foundry Co., Detroit, and a 20-ton open-hearth furnace for the Monarch Steel Castings Co., Detroit.

WEIGHT OF ELLIPTICAL BARS PER RUNNING INCH

By W. C. Tryon



The following tables give the weights of elliptical bars of cast iron, steel, aluminum, copper, zinc, gun metal and yellow brass in one-inch lengths. To find the weight of an elliptical bar of these materials of any given length, multiply the weight per running inch from the tables by the total length of the bar in inches.

		Weight of Bar 1 Inch Long When Cast In						
d	D	Cast iron	Steel	Alum-inum	Cop-per	Zinc	Gun metal	Yellow brass
¾	1	.153	.167	.057	.188	.149	.186	.178
¾	1¼	.192	.209	.071	.235	.186	.232	.223
¾	1½	.230	.251	.085	.283	.223	.279	.268
¾	1¾	.268	.292	.099	.330	.260	.325	.312
¾	2	.307	.334	.113	.377	.297	.371	.357
¾	2¼	.345	.376	.128	.424	.335	.418	.401
¾	2½	.383	.418	.142	.471	.372	.464	.446
¾	2¾	.422	.460	.156	.518	.409	.511	.491
¾	3	.460	.501	.170	.565	.446	.557	.535
1	1¼	.256	.278	.095	.313	.248	.309	.297
1	1½	.307	.334	.114	.375	.297	.371	.356
1	1¾	.358	.389	.133	.438	.347	.433	.416
1	2	.409	.445	.152	.500	.397	.495	.475
1	2¼	.460	.501	.170	.564	.446	.557	.535
1	2½	.511	.556	.190	.625	.496	.619	.594
1	2¾	.562	.612	.209	.688	.545	.681	.653
1	3	.613	.667	.228	.750	.595	.743	.712
1	3½	.716	.779	.265	.875	.694	.866	.851
1	4	.818	.890	.303	1.00	.793	.990	.950
1¼	1½	.384	.418	.142	.471	.372	.464	.446
1¼	1¾	.448	.487	.166	.548	.434	.542	.519
1¼	2	.512	.556	.190	.625	.496	.619	.594
1¼	2¼	.576	.626	.212	.705	.558	.697	.668
1¼	2½	.640	.694	.236	.784	.620	.774	.742
1¼	2¾	.704	.764	.259	.862	.682	.851	.816
1¼	3	.768	.833	.283	.941	.744	.929	.890
1¼	3½	.896	.971	.331	1.10	.868	1.08	1.04
1¼	4	1.02	1.11	.378	1.25	.992	1.24	1.19
1¼	4½	1.15	1.25	.425	1.41	1.12	1.39	1.34
1¼	5	1.28	1.39	.473	1.57	1.24	1.55	1.48
1½	1¾	.537	.585	.198	.659	.520	.650	.624
1½	2	.613	.667	.227	.753	.595	.743	.713
1½	2¼	.690	.752	.255	.848	.669	.835	.803
1½	2½	.767	.835	.283	.942	.743	.928	.892
1½	2¾	.843	.919	.312	1.04	.818	1.02	.981
1½	3	.920	1.00	.340	1.13	.892	1.11	1.07
1½	3½	1.07	1.17	.397	1.32	1.04	1.30	1.25
1½	4	1.23	1.34	.453	1.51	1.19	1.49	1.43
1½	4½	1.38	1.50	.510	1.69	1.34	1.67	1.61
1½	5	1.53	1.67	.567	1.88	1.49	1.86	1.78
1½	5½	1.69	1.84	.624	2.07	1.63	2.04	1.96
1½	6	1.84	2.01	.681	2.26	1.78	2.23	2.14
2	2½	1.02	1.11	.378	1.25	.992	1.24	1.19
2	3	1.23	1.34	.455	1.51	1.19	1.49	1.43
2	3½	1.43	1.56	.530	1.76	1.39	1.73	1.66
2	4	1.64	1.78	.606	2.01	1.59	1.98	1.90
2	4½	1.84	2.01	.681	2.26	1.78	2.23	2.14
2	5	2.05	2.23	.758	2.51	1.98	2.48	2.38
2	5½	2.25	2.45	.833	2.76	2.18	2.72	2.61
2	6	2.46	2.67	.909	3.01	2.38	2.97	2.85
2	7	2.86	3.12	1.06	3.51	2.78	3.47	3.33
2	8	3.27	3.57	1.21	4.01	3.17	3.96	3.80

(*Concluded on Data Sheet No. 284*)

WEIGHT OF ELLIPTICAL BARS PER RUNNING INCH

By W. C. Tryon

(*Concluded from Data Sheet No. 283*)

		Weight of Bar 1 Inch Long When Cast In						
d	D	Cast iron	Steel	Alum-inum	Cop-per	Zinc	Gun metal	Yellow brass
2½	3	1.53	1.67	.567	1.88	1.49	1.86	1.78
2½	3½	1.79	1.95	.662	2.19	1.74	2.17	2.08
2½	4	2.05	2.23	.756	2.51	1.98	2.48	2.38
2½	4½	2.30	2.50	.851	2.82	2.23	2.79	2.67
2½	5	2.56	2.78	.955	3.14	2.47	3.10	2.97
2½	5½	2.81	3.06	1.05	3.45	2.72	3.40	3.26
2½	6	3.06	3.34	1.14	3.77	2.97	3.71	3.56
2½	7	3.57	3.90	1.33	4.40	3.47	4.33	4.15
2½	8	4.08	4.45	1.52	5.02	3.97	4.95	4.75
2½	9	4.59	5.01	1.71	5.65	4.46	5.57	5.34
2½	10	5.11	5.56	1.89	6.27	4.96	6.19	5.94
3	3½	2.14	2.34	.797	2.63	2.08	2.60	2.49
3	4	2.46	2.67	.909	3.01	2.38	2.97	2.85
3	4½	2.76	3.01	1.02	3.39	2.68	3.34	3.21
3	5	3.06	3.34	1.13	3.76	2.98	3.71	3.56
3	5½	3.37	3.68	1.25	4.14	3.27	4.08	3.92
3	6	3.68	4.01	1.36	4.52	3.57	4.45	4.28
3	7	4.29	4.68	1.58	5.27	4.16	5.19	4.99
3	8	4.90	5.35	1.81	6.02	4.76	5.93	5.71
3	9	5.52	6.01	2.03	6.77	5.35	6.68	6.42
3	10	6.13	6.68	2.26	7.53	5.95	7.42	7.13
3	11	6.74	7.35	2.49	8.28	6.54	8.16	7.84
3	12	7.36	8.01	2.72	9.03	7.14	8.91	8.55
3½	4	2.86	3.12	1.06	3.51	2.78	3.47	3.33
3½	4½	3.22	3.51	1.19	3.95	3.13	3.91	3.74
3½	5	3.57	3.90	1.33	4.40	3.47	4.33	4.15
3½	5½	3.93	4.29	1.46	4.83	3.81	4.76	4.57
3½	6	4.29	4.69	1.58	5.27	4.16	5.19	4.99
3½	7	5.01	5.47	1.84	6.15	4.86	6.05	5.82
3½	8	5.72	6.24	2.11	7.02	5.55	6.92	6.66
3½	9	6.44	7.01	2.39	7.90	6.25	7.79	7.49
3½	10	7.15	7.78	2.65	8.79	6.94	8.67	8.32
3½	11	7.87	8.56	2.91	9.66	7.64	9.54	9.15
3½	12	8.58	9.34	3.17	10.53	8.33	10.40	9.97
4	4½	3.68	4.01	1.36	4.51	3.57	4.46	4.28
4	5	4.08	4.45	1.52	5.02	3.97	4.95	4.75
4	5½	4.49	4.90	1.67	5.52	4.36	5.44	5.23
4	6	4.90	5.35	1.81	6.02	4.76	5.93	5.71
4	7	5.72	6.24	2.11	7.02	5.55	6.92	6.66
4	8	6.54	7.13	2.42	8.03	6.35	7.92	7.61
4	9	7.36	8.01	2.72	9.03	7.14	8.91	8.55
4	10	8.17	8.89	3.02	10.03	7.94	9.91	9.50
4	11	8.99	9.78	3.33	11.04	8.73	10.90	10.45
4	12	9.81	10.68	3.63	12.04	9.52	11.89	11.40
4½	5	4.59	5.01	1.71	5.65	4.46	5.57	5.34
4½	5½	5.06	5.51	1.88	6.21	4.91	6.12	5.87
4½	6	5.52	6.01	2.05	6.77	5.35	6.68	6.42
4½	7	6.44	7.01	2.39	7.90	6.25	7.79	7.49
4½	8	7.36	8.01	2.72	9.03	7.14	8.91	8.55
4½	9	8.28	9.01	3.06	10.16	8.03	10.02	9.62
4½	10	9.19	10.01	3.40	11.29	8.93	11.14	10.69
4½	11	10.11	11.01	3.74	12.42	9.82	12.25	11.76
4½	12	11.04	12.02	4.08	13.54	10.71	13.37	12.82
5	6	6.13	6.67	2.27	7.53	5.95	7.43	7.13
5	7	7.15	7.78	2.65	8.79	6.94	8.67	8.32
5	8	8.17	8.89	3.02	10.03	7.94	9.91	9.51
5	9	9.19	10.01	3.40	11.29	8.93	11.14	10.69
5	10	10.22	11.12	3.78	12.54	9.92	12.38	11.88
5	11	11.24	12.23	4.16	13.79	10.91	13.62	13.07
5	12	12.27	13.35	4.54	15.05	11.90	14.86	14.25
6	7	8.58	9.34	3.17	10.53	8.33	10.40	9.97
6	8	9.81	10.68	3.63	12.04	9.52	11.89	11.40
6	9	11.04	12.02	4.08	13.54	10.71	13.37	12.82
6	10	12.27	13.35	4.54	15.05	11.90	14.86	14.25
6	11	13.49	14.69	5.00	16.56	13.09	16.34	15.67
6	12	14.72	16.02	5.45	18.07	14.28	17.83	17.10

THE FOUNDRY DATA SHEET, MAY 1, 1919
Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

Note—This sheet may be cut into two sections, 6 x 7 inches, and may be readily bound in note book form.

Metallography Applied to Nonferrous Metals---III

The Copper-Aluminum Series is Discussed and the Equilibrium Diagram is Explained—Properties of the Aluminum Bronzes Also Are Considered

By Ernest J Davis

THE next most important series of the numerous copper alloys is that of copper and aluminum. The equilibrium diagram, Fig. 1, must be regarded as somewhat tentative, although it is one of the latest published. This diagram was presented before the British Foundrymen's association, in December, 1915, by Prof. C. A. Edwards, and contains a number of peculiar features some of which have not not yet been fully explained. The liquidus consists of seven branches corresponding with the separation of seven solid phases; one of these corresponds to the separation of a compound, Cu Al_2, and the others to solid solutions. The branch *B C* shows a maximum at *D*, the composition of which agrees with the formula Cu_3 Al, with 87.6 per cent of copper. There are two minimums, one at about 9 per cent and the other at 68 per cent of aluminum at a temperature of 545 degrees Cent. and corresponds to the formation of the eutectic of Cu Al_2 and the η (eta) solution. The alpha solid solution of this series may contain as much as 9 per cent of aluminum; it varies in color from copper-red to golden-yellow, according to its composition. Like the alpha solution of the copper-zinc and copper-tin series, it readily undergoes twinning when subjected to plastic deformation followed by annealing. In its mechanical properties, however, the copper-aluminum alpha phase differs widely from that of the other copper alloys. It might be mentioned that this series of alloys exhibits a peculiar property. It will be noted from the Fig. 1 that unlike the other systems discussed, there is no long freezing-range for the alpha phase; the liquidus and solidus lie so close together that it is difficult to distinguish the one from the other, in fact, as indicated in Fig. 1, they are drawn as one. It is a direct consequence of this circumstance that the portions of the alpha phase which crystallize first do not differ very much in composition from the portions which solidify last, and as a result of this, the cast alloys consisting entirely of the alpha phase do not exhibit that well-known dendritic structure which so frequently occurs in solid solutions. At the point *B*, Fig. 1, it will be noticed that a definite minimum occurs in the liquidus. When such a minimum occurs in a series of alloys, it usually signifies the formation of a definite eutectic, but in this case, it is not so, and the minimum at *B* seems similar to that which occurs in the copper- manganese alloys, being simply formed in an unbroken series of solid solutions. From the point *B* the liquidus rises to a maximum at *D*, which corresponds to the formation of the compound Cu_3 Al. From the diagram, Fig. 1, it will be apparent that the microstructure of alloys containing up to about 9 per cent of aluminum is that of a homogeneous solid solution, alpha

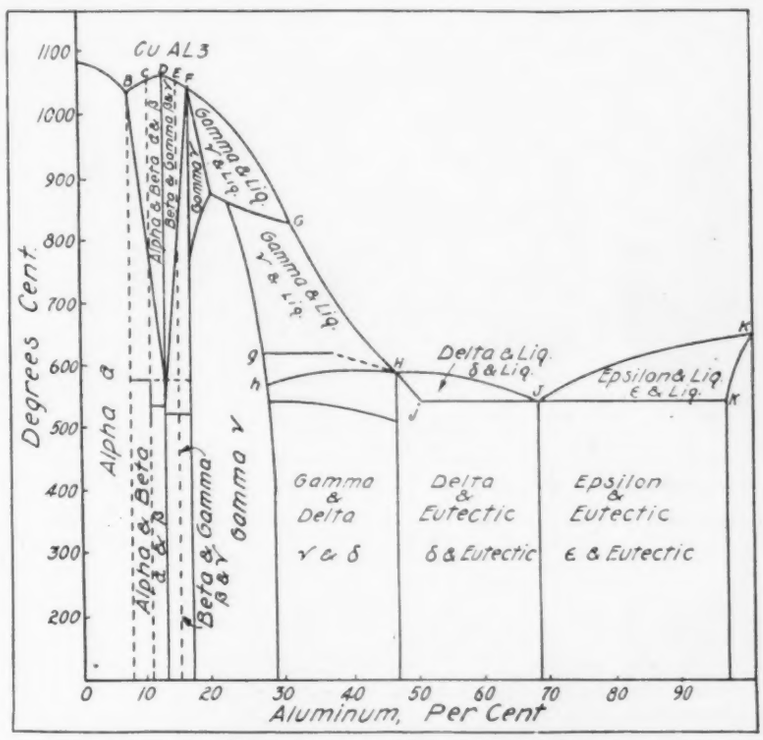


FIG. 1—EQUILIBRIUM DIAGRAM OF THE COPPER-ALUMINUM SERIES

Fig. 2. The microstructure of alloys containing a larger percentage of aluminum changes from that of a simple alpha phase to a duplex structure. Since the field of the alpha phase is bounded by the sloping line *Bb*, it is evident that the microstructure, and consequently the mechanical properties of alloys of compositions lying at the right of the point *b*, about 12.5 per cent of aluminum, vary according to the method of cooling. Such alloys, when in a state of equilibrium, should consist of the alpha phase only. The change from beta to alpha in crossing the line *Bb*, however, is slow and, consequently, alloys under 12.5 per cent aluminum, ordinarily cooled, contain varying portions of a new phase, namely beta. When examined microscopically, this etches dark between the light alpha grains. Fig. 3 shows the duplex structure of a 10 per cent aluminum alloy, magnified 100 diameters. As the composition *D* is approached, the proportion of the beta phase gradually increases until, at the composition *D* the alpha phase disappears entirely and the alloys consist of the homogeneous beta phase. This beta phase is very hard and brittle and alloys containing the single beta phase have lost all ductility. This furnishes another example of a general rule, that intermetallic compounds have no mechanical usefulness owing to their extreme brittleness. It is evident from the foregoing that the rate of cooling of these alloys in this range determines their mechanical properties to a large extent; thus, a chill casting, apart from the increased fineness of the grain, will contain more of the hard and brittle constituent and, therefore, it will be stronger and less ductile than a corresponding sand casting; a quenched sample, if the composition and temperature are chosen according to the

equilibrium diagram, may consist of the homogeneous beta phase and will have very little mechanical usefulness.

By such reading of the equilibrium diagrams, the foundryman may better understand his alloys and he is in a position to choose his alloys and their treatment according to the required mechanical properties.

In the region of 8 to 15 per cent of aluminum, Fig. 1, a number of horizontal lines will be noted, indicating that some internal changes take place in the solid alloys. According to some authorities, the horizontal at 565 degrees Cent. should extend from about 82 per cent of aluminum to 15 per cent of aluminum and that it represents a breakdown of the beta phase similar to that recorded by Prof. Carpenter for the copper-zinc alloys. As the microscopic examination of these alloys shows that a breakdown of the beta phase takes place at about 500 degrees Cent., it would be correct to continue the horizontal line at 560 degrees Cent., from 8 to 15 per cent of aluminum as suggested, and to raise the point *b* slightly; the phases stable at the ordinary temperatures then would be alpha and gamma instead of alpha and beta as shown.

Fig. 4 is a microphotograph of alloy, Fig. 3, annealed at 560 degrees Cent. for three hours and shows alpha (light) surrounded by beta-gamma. The gamma phase, which is white, is brittle and weak, similar to that of the copper-zinc gamma phase, and alloys containing it have similar mechanical properties and are useless for engineering purposes. The compound, Cu Al_2, corresponds to a composition of 54 per cent of copper and melts at 590 degrees Cent.; it is a strongly crystalline body, occurring in the form of long bars with sharply angular contours, Fig. 5. The eutectic formed at *J*, Fig. 1, is brittle and as soon as it makes its appearance in the alloy the same property is imparted to the alloy. An alloy containing 50 per cent of aluminum is weak and can be broken readily into powder. For this reason it is useful in the preparation of alloys in the foundry as it can be weighed out to the desired quantities. The structure of this alloy, as indicated by Fig. 1, consists of crystals of delta solid solution surrounded by a network of eutectic, which is direct evidence of its brittleness. Fig. 6 shows a 50-50 alloy under the microscope, magnified 100 diameters.

Copper Limit Fixed

The limit of solid solution of copper in aluminum is placed at 4 per cent by most authorities. This composition also limits the alloys which can be rolled into bars. Fig. 7 shows the microstructure of an alloy containing 8 per cent of aluminum, magnified 100 diameters. At first some difficulty was encountered in casting alloys of copper and aluminum, or aluminum bronzes, as they are called. The difficulty was twofold and was due to the rapidity at which aluminum oxidizes and to the refractory nature of the oxide so formed. Alumina, the oxide formed when aluminum oxidizes in the air, is extremely difficult to flux and if enclosed in the alloy, forms a film around the grains of the alloy and results in a porous casting. Fluxes are of little use in the melting of aluminum alloys, although charcoal should be used in melting down the copper and in the manufacture of the light alloys. Zinc-chloride usually is used, but good castings can be made by the careful handling of the alloy.

The alloys of copper and aluminum with other metals have received a good deal of attention. The ternary system (alloys of two metals are called binary, those of three are called ternary and of four quarternary alloys) of aluminum-tin-copper have been studied by Edwards and Andrews, while Rosenhain and Lantsbury have investigated the system of aluminum-copper-manganese alloys. The addition of manganese to the aluminum bronzes, so far as alloys towards the copper end of the series is concerned, appear to result in a slight increase of strength without a reduction of ductility, provided that the manganese addition is small or that the alloy in question has an aluminum content below 10 per cent. The alloys containing manganese possess a still greater resistance to corrosion than those of the binary copper-aluminum series and excel tool steel in their resistance to abrasion.

In the light alloys containing less than 4 per cent of copper, the addition of manganese was found to be an advantage, but the quantity which can be added safely is limited by the fact that aluminum and manganese form a compound, Al_3 Mn, which is a hard and brittle body and one, which if present in any large extent in the alloy, tends to cause the alloy to fall to pieces spontaneously. Therefore, additions of manganese to the light alloys of copper and aluminum are confined to 2 per cent.

An alloy of alumnium with about 3 per cent of copper and 1 per cent of manganese was at one time and probably still is the best light alloy known and by the addition of 0.5 per cent of magnesium; it is converted into the alloy known as duralumin.

The presence of this small quantity of magnesium appears to confer on this alloy a peculiar property of hardening slowly in the course of several days after it has received an appropriate heat treatment; this consists of quenching from a temperature between 400 to 500 degrees Cent. The alloy then is in a malleable condition and can be worked in the cold. The exact nature of this

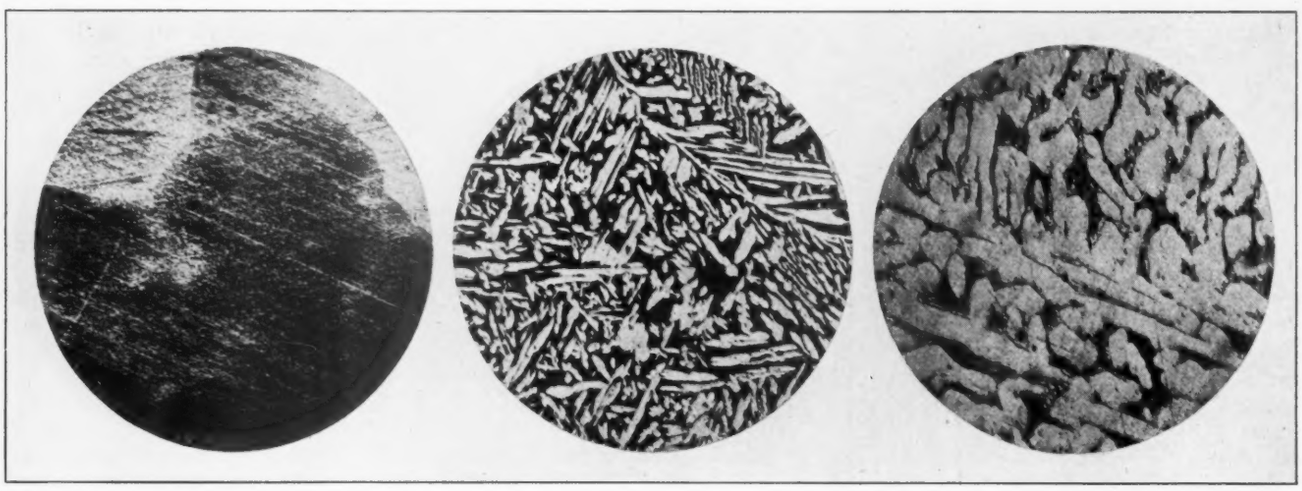


FIG. 2—MICROPHOTOGRAPH OF A HOMOGENEOUS ALPHA SOLID SOLUTION; MAGNIFIED 100 DIAMETERS

FIG. 3—MICROPHOTOGRAPH OF THE DUPLEX STRUCTURE OF A 10 PER CENT ALUMINUM ALLOY; MAGNIFIED 100 DIAMETERS

FIG. 4—ALLOY, FIG. 3, ANNEALED FOR THREE HOURS AT 560 DEGREES CENT.; MAGNIFIED 100 DIAMETERS

hardening process is not understood, but it results in very nearly doubling the tensile strength of the alloy without seriously reducing the ductility. There is no visible change in the microstructure and this remarkable hardening property is one of the unsolved scientific mysteries.

The addition of iron to the aluminum bronzes forms another important series partially worked out by W. M. Corse and G. F. Comstock. Taking an alloy containing 7 per cent of aluminum, we obtain a homogeneous alpha solid solution, Fig. 2, which is capable of dissolving iron up to about 4 per cent when a new constituent makes its appearance in the form of bluish-grey crystallites scattered sparingly throughout the yellow alpha crystals. With the these soon meet one another and prevent large growths.

With the alloys containing 10 per cent of aluminum, which have a duplex structure (alpha + beta), the additions of iron behave in much the same way as with the 7 per cent of aluminum series. The iron is soluble to the extent of about 4 per cent as before, but with this series the bluish gray con-

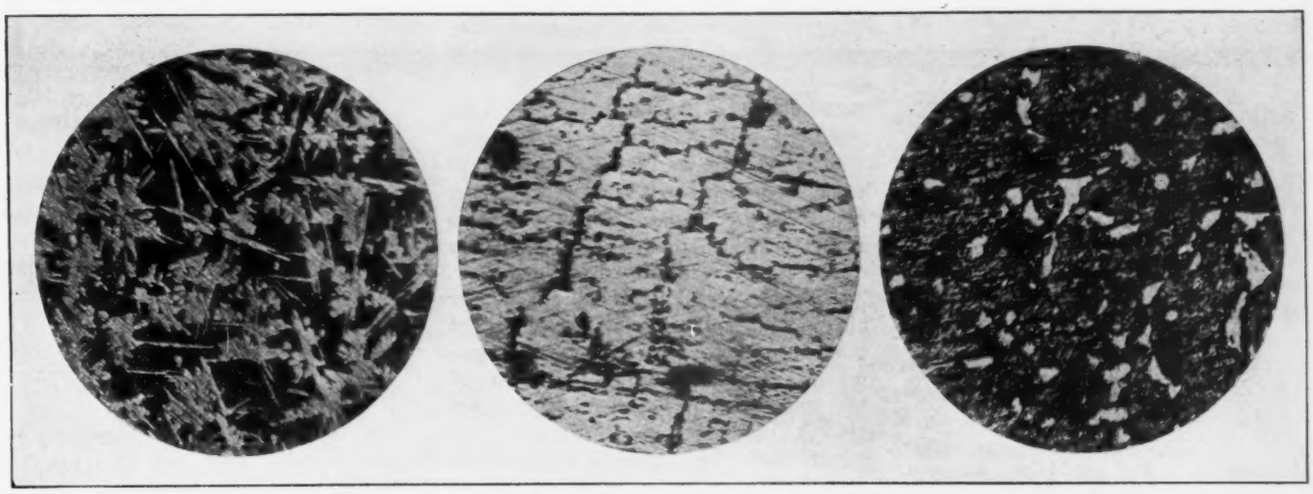


FIG. 5—STRONGLY CRYSTALLINE ALLOY CONTAINING 54 PER CENT COPPER; MAGNIFIED

FIG. 6—MICROPHOTOGRAPH OF A 50-50 ALLOY; MAGNIFIED 100 DIAMETERS

FIG. 7—ALLOY CONTAINING 8 PER CENT OF ALUMINUM; MAGNIFIED 100 DIAMETERS

of the ternary alloys. When aluminum bronze first became a commercial possibility, to obtain the best results it was believed that the purest possible materials only should be used. Iron was supposed to be especially deleterious and the precaution of coating the stirring rods and other furnace tools with a protective coating was carried out. Now we know that this is unnecessary and such ideas probably were due to the prejudice which some foundrymen have against iron as an ingredient of copper alloys. However, this prejudice is not without some foundation in fact, because unless the iron is in solution in the brass it collects in small pellets or segregations of an iron-rich alloy, which are so hard that they entirely destroy the machining properties of the brass.

Addition of Iron Beneficial

No difficulty is experienced in dissolving iron in the aluminum bronzes and an alloy of 8 to 10 per cent of aluminum and 1 to 5 per cent of iron, the balance copper, is made easily. Such a mixture is far superior to the ordinary 10 per cent aluminum bronze because the addition of iron prevents the excessive crystal growth which is such a drawback to the use of ordinary aluminum bronzes. The use of iron in alloys containing up to 10 per cent of aluminum is not new, as this element has been in service for many years as an ingredient of alloys of copper and aluminum. The micro-structure of this important series of alloys has been addition of small percentages of iron to aluminum bronzes, not only does the element dissolve in the alpha solution, but a marked difference in grain size is noted, which accounts, to a large extent, for the superior tests obtained with these alloys containing iron. The composition of the bluish-gray con-

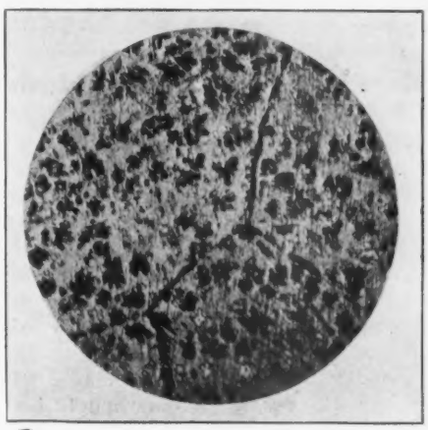


FIG. 8—A 10 PER CENT ALUMINUM BRONZE CONTAINING 4 PER CENT OF IRON; MAGNIFIED 100 DIAMETERS

stituent is not known, but undoubtedly it consists chiefly of iron with some aluminum and copper. This crystalline constituent is the first to crystallize out when solidifying and forms numerous nuclei for the beginning of crystallization of the alpha crystals; the fine grain of these iron alloys is brought about by the numerous centers of crystallization which form many small grains; stituent has a slightly different appearance, namely in groups of rounded spots. The addition of iron to the 10 per cent series, as in the previous series, refines the grain and breaks up the arrangement of elongated alpha crystals which frequently occur parallel with the cleavage planes of the large crystal grains. The alpha crystals become rounded or are of an irregular shape, such a structure giving better physical properties than the structure ordinarily found in 10 per cent aluminum bronzes. Fig. 8 shows a 10 per cent aluminum bronze with 4 per cent of iron having a bluish-gray constituent.

Die Casting Considered

While there is no question that iron improves the properties of the aluminum bronzes for sand castings, its use in die-casting is open to question. In the first place, it is not needed to refine the grain, as the chilling effect of the die is sufficient to keep down excessive crystal growth, secondly, it accentuates the shrinkage of the bronze, increasing the difficulty of obtaining castings free from the pear-shaped cavities, which it seems almost impossible to eliminate entirely from die-castings of aluminum bronzes. But a careful study of the gating and venting in the die-casting process may lead to the successful elimination of such defects which may not be due entirely to the excessive shrinkage of these alloys. The alloys of aluminum and copper containing iron have an-

other valuable property; they are not brittle at any stage up to a bright red heat; the metal must be partially melted before it can be broken, therefore there is no danger of a casting breaking when dropped on the floor while hot. This property is a decided advantage in the foundry where the hot castings are handled.

HOW AND WHY IN BRASS FOUNDING

By Charles Vickers

Casting Copper Bars and Washers

We recently had trouble in attempting to make copper castings, in the form of bars 24 inches long by 1½ inches thick. We poured these on the incline, forcing the metal uphill and into a riser on the highest end of the casting, which was about 2½ inches in diameter; but the castings were always poor and spongy. We had the same experience in making copper washers, 4 inches in diameter, 1 inch thick, with a 1-inch core through the center. In both cases we could get no more than 50 per cent of all the castings solid and marketable. We used half new metal and half heavy wire scrap. Then again we used all new metal. We melted in a gas-fired furnace under a heavy layer of charcoal. In some heats we added a copper flux, and in others we used no flux at all.

The question arises, whether a deoxidizing agent was added to the copper. The flux mentioned is merely a covering for the metal and protects it from the action of the atmosphere, and for this purpose is good, but it will not deoxidize and make copper castings free from porosity. It is essential that some element be added to the copper, that has a greater affinity for the gases that cause porosity, than the copper. This element must combine with the gases to form a solid substance which rises to the surface of the copper as a slag. The fact remains that it is necessary to add something to the copper to make it cast soundly. Many substances are used for this purpose; the selection of the one to use depending upon the service to which the castings are to be put. Thus, if the castings are to be pure and of high electrical conductivity, the selection is narrowed down to one or two elements, but if conductivity is unessential the deoxidizer that will produce the best castings should be selected. This element is zinc, but it should never be added to copper as a metal, but alloyed with copper in the form of yellow brass. This is because the alloyed zinc diffuses throughout the copper with less loss from oxidation than when added in the metallic form. Use sheet yellow brass, pounded together until solid, so that it will not be liable to float and burn away. The brass will contain probably 70 per cent copper and 30 per cent zinc. About 6 pounds should be added to the copper, and less if the copper was properly melted.

About 1 per cent of silicon copper also will produce solid castings and some have successful results with magnesium, added in the form of a 10 per cent magnesium copper, using 1 per cent. Phosphorus also is used, and one formula for ordinary copper castings consists of 3 pounds of yellow brass and 1 pound of 5 per cent phosphor tin. This makes an easily cast metal. In casting long copper bars, broad and flat in cross-section, the best way to mold them is to make them edgewise, and gate them as described. If cast edgewise, the bars will come cleaner than if cast with the broad, flat sides in the cope and drag. If there is any shrinkage of the castings, the riser should be increased in diameter, but if not, the present size is large enough.

Alloys Used for Aluminum Pistons

We would like to obtain a formula suitable for making pistons of aluminum.

An alloy that casts easily and is frequently used for the purpose mentioned follows: Aluminum, 92 per cent; copper, 8 per cent. This is known as No. 12 aluminum. It has a tensile strength ranging from 16,000 to 20,000 pounds per square inch; a specific gravity of 2.8, and a Brinell hardness of 50 to 55.

Another alloy follows: Aluminum, 94 per cent; copper, 4 per cent, and 10 per cent magnesium copper, 2 per cent; the copper can be introduced directly into the aluminum provided the latter is brought to a red heat and the copper is in the form of a thin sheet. The magnesium copper is made by melting 88 per cent copper and adding 12 per cent stick magnesium. The resulting alloy is sufficiently brittle that it may be pounded in small pieces. It will then dissolve in the aluminum. A portion of the aluminum charge should be reserved for use in cooling to bring the bath to the correct temperature after the copper is dissolved.

Making Phosphor Tin in the Foundry

We would like to obtain information regarding the best methods for making phosphor tin and phosphor copper. We have used a plunger to introduce the phosphorus, but the results have been unsatisfactory. We melt the tin at a low temperature with charcoal on top and then plunge the loaded phosphorizer into the metal.

The best way to make phosphor tin in the foundry is to first shot the tin, then weigh the required phosphorus and always use the same weights of shotted tin and stick phosphorus. Get a large crucible, an old one will do, and have it dry and warm. Place a layer of the shotted tin in the bottom of the crucible and on that, a layer of phosphorus, covered with another layer of tin, and so on until the crucible is filled with the tin and the phosphorus arranged alternately.

When the charge is completed, simply drop the crucible into the furnace, but do not coke it. The phosphorus will inflame as soon as the heat reaches it and the tin will melt and become alloyed with the phosphorus while the fumes will pass up the stack. After the metal is fluid, remove and pour into ingots and have an analysis of the ingots made before going any further. If 10 per cent of phosphorus is added, the phosphor tin will contain between 8 and 9 per cent, and has been known to be over 9 per cent. The analysis will give the percentage of phosphorus and, as the weights of phosphorus and tin are known, if the same method is followed throughout in subsequent heats, there will be little variation in the phosphorus content of the tin. The tin should contain 5 per cent of phosphorus and the heats following the first should be brought to this figure by adding tin to the phosphor tin before it is poured into ingots. If the analysis shows 8 per cent phosphorus in the tin, a little calculation will give the amount of pig tin to add to each heat to produce an alloy containing 5 per cent of phosphorus. Phosphor copper is more difficult to make but it is not necessary to use it if phosphor tin is employed.

Preventing Porosity in an All-Scrap Mixture

We are making pump plungers which are molded upright and are gated at the bottom. When the castings come out of the mold, they appear perfectly clean, but when machined they develop holes, ranging in size from a pin head to that of a finger tip. We use all scrap metal.

The trouble is caused by gases generated in the metal by reactions between various chemical agents such as sulphur, carbon, oxygen and hydrogen, but usually if we can keep out sulphur and oxygen, the castings will be sound to the eye, in spite of the presence of the other gases. The sulphur is absorbed from the fuel, and the oxygen from the air, and in working with new metals there is some chance of controlling these factors, but this opportunity is not accorded us in the case of scrap, as there is no way of knowing how they have been handled in their former state.

In this case it is advisable to add a deoxidizer and to melt under a cover of charcoal and common salt to keep out sulphur as much as possible. Phosphorus is an excellent deoxidizer; it should be added in the form of 15 per cent phosphor copper, and the amount to add will vary with the metal and the conditions under which the furnaces operate. About 0.25 per cent should be sufficient, but in some cases it has been found necessary to add 0.5 per cent and up to 1.5 per cent of phosphor copper. If there is much zinc in the alloy, use only a small amount of phosphorous, and if the metal fumes strongly, it would be advisable to use 0.5 per cent of 30 per cent manganese copper as a deoxidizer.

Allen Metal Mixture

What is the composition of Allen Metal and an alloy known as Bakelite? The lotter is supposed to contain about 90 per cent aluminum and 8 per cent copper. This alloy is said to be suitable for gyroscopic castings and is reported to be immune to the corrosive influence of salt water. What is the composition of titanium aluminum bronze?

An analysis of Allen metal gave the following results: Copper, 55.25 per cent; lead, 44.61 per cent and tin, 0.14 per cent. This is practically an alloy of 50 per cent copper and 50 per cent lead, and these proportions usually are employed in making the metal, the tin content being ignored.

Bakelite is not a metal, but a substance that appears in many forms. It may be similiar to amber and is used for the mouthpieces of pipes, or it may resemble hard rubber. It is made from carbolic acid, or phenol and formaldehyde. There is no aluminum alloy known by this name. The formula given is an excellent one for any kind of aluminum castings, and can be used wherever aluminum is demanded.

Titanium aluminum bronze consists of copper, aluminum and usually iron. A similar alloy that will fulfill all purposes of this bronze is the following: Copper, 88.50 per cent; 30 per cent manganese copper, 0.5 per cent; aluminum, 10 per cent and iron, 1 per cent. Melt the copper under charcoal, add the iron in the form of loosely coiled tin plate, follow with the aluminum and charge the manganese copper last. The addition of the latter has a good effect on the appearance of the alloy. One per cent of manganese chloride can be used in place of the manganese copper. Gate the castings at their lowest point and use very large risers to feed the mold.

Pitting in Aluminum Bronze

We have a quantity of aluminum bronze castings to make and are experiencing difficulty due to the castings being pitted all over after they are turned. These pits are very small and also very numerous. The mixture we are using consists of aluminum 93 per cent and copper, 7 per cent. The metal is melted in oil-fired furnaces.

An alloy of aluminum 93 per cent and copper 7 per cent, is not usually considered an aluminum bronze, as this term is reserved for the alloys at the other end of the scale, those containing copper with up to 15 per cent of aluminum. The difficulty in this case is due to casting the metal at too high a temperature. The remedy is to cool the metal as much as possible before pouring it into the molds. To make aluminum castings successfully from an oil-fired furnace requires careful manipulation, and it will assist materially if the metal is never allowed to get above a dull red temperature while in the furnace. Use a small amount of zinc chloride for a flux. Just enough to disentangle the oxides from the metal so the dross arises as a powdery substance is sufficient. To make aluminum bronze, first melt the copper under plenty of charcoal, and when it is well melted and clear under its cover, add the aluminum a small piece at a time and stir well after each addition with an iron stirrer. Do not use any flux of any kind on aluminum bronze, otherwise the metal will be pitted, and just before pouring add about a pound of manganese copper to the hundred pounds of aluminum bronze. Aluminum bronze should never be poured just after the aluminum has been added, but it should be given a little time to cool in the furnace before it is removed and poured.

Substituting a Cheaper Alloy for a High Tin Bronze

We are making bronze roller bearing separators using an alloy consisting of copper, 90 per cent and tin, 10 per cent and we would like to be informed if it is possible to substitute a cheaper alloy which will serve the same purpose. The alloy must have good tensile strength and bearing qualities for light duty.

It is not possible to obtain the same hardness in a cheaper alloy because to be cheaper it must contain less tin, and it is the latter metal that hardens the copper; the more tin that the alloy contains the harder it will be. The hardness of this alloy will be from 65 to 70 Brinell; if the tin is reduced to 6.5 per cent the hardness of the alloy will be from 50 to 60 Brinell. The latter alloy will have practically the same tensile strength as the one you are using and in spite of its being softer, might be used to advantage; its composition follows: Copper, 90 per cent; tin, 6.5 per cent; lead, 1.5 per cent, and zinc, 2 per cent.

Aluminum bronze would be suitable for such a purpose as these separators are used for, and as the castings are light in section, there should be no difficulty in using this alloy. To produce it, melt 89 pounds of copper (electrolytic) under charcoal, and when thoroughly liquid, add one pound of thin, clean sheet iron, such as tin plate, loosely coiled. Stir well with an iron poker and add gradually 10 pounds of aluminum and stir again. Just before pouring, add 1 per cent of manganese copper. This alloy will have a hardness of 92 to 96, and will be very much stronger and more ductile than the tin bronze now being used.

Alloys for Die Casting

We would like a formula for a zinc-base die casting alloy that is hard and sharp casting. Also the formula for a tin-base die-casting alloy must also be hard and sharp casting in order to answer our purpose.

An excellent zinc-base die-casting alloy is lumen metal, which consists of zinc, 86 per cent; copper, 10 per cent, and aluminum, 4 per cent. The Brinell hardness of this alloy chill cast is, 119 to 124; its specific gravity, 6.9; tensile strength around 40,000 pounds chill cast. It has no elongation. A second alloy consists of zinc, 85 per cent; tin, 10 per cent; copper, 3 per cent, and aluminum, 2 per cent. For a tin-base alloy the following will be satisfactory: Copper, 8.33 per cent; antimony, 8.33 per cent; tin, 83.34 per cent.

Novel Method of Drying Cores in Vacuum Ovens

Satisfactory Experiments Have Been Made and a Battery of Ovens is to be Constructed That Will Reduce Fuel Cost, Breakage Loss and Will Insure Thorough Baking

By G W Merrefield

THE question of core drying has been given considerable attention by foundrymen. A careful study of the problem indicates that the results desired are, (a) the removal of moisture and (b) the oxidization of the bond. To attain result (a) as quickly as possible, a great many core ovens are heated to a temperature which is destructive to the organic bonding material in the cores. This results in a weaker core or makes necessary the use of more bonding material than is necessary to attain the desired strength. In the ordinary core oven, maintaining a low temperature is difficult and if it were easy of accomplishment it would necessitate a greater oven capacity, because of the time needed to remove the moisture at a lower temperature.

It occurred to me that the ideal method of drying the cores would be by diminished pressure at a low temperature. Reducing the pressure below atmospheric pressure, lowers the boiling point of the moisture in the cores and makes it possible to dry them at a low temperature, which would give the maximum effect of the bonding materials.

Vacuum Oven Constructed

To test this out I made a small vacuum oven as follows: A 3-inch pipe, 1 foot long, was fitted with a permanent cap at one end and a removable cap at the other end. The removable cap was fitted with two stopcocks and two hobs for a thermometer and a mercury vacuum tube. One of the stopcocks was connected to an exhaust pump and the other to a hot air oven, heated to 250 degrees Fahr. The cylinder was immersed in a tank of linseed oil heated to 250 degrees Fahr.

Two cores were baked at a time in this oven by placing them on a rack in the pipe and screwing on the top cap. The stopcock connected to the air oven was closed and the one to the exhaust pump was opened. When the air in the oven was exhausted to the limit of the pump (18 inches of mercury), the valve to the hot air oven was opened until atmospheric pressure was restored in the cylinder, and then again closed. This procedure was repeated until the cores were dried.

Comparative drying tests on small cores of the same size, made from the same batch of sand, showed that the vacuum drying at 250 degrees Fahr., with 18 inches of vacuum, was complete in from 15 to 25 minutes, while cores dried in a gas oven at 350 degrees Fahr. took 45 minutes to com-

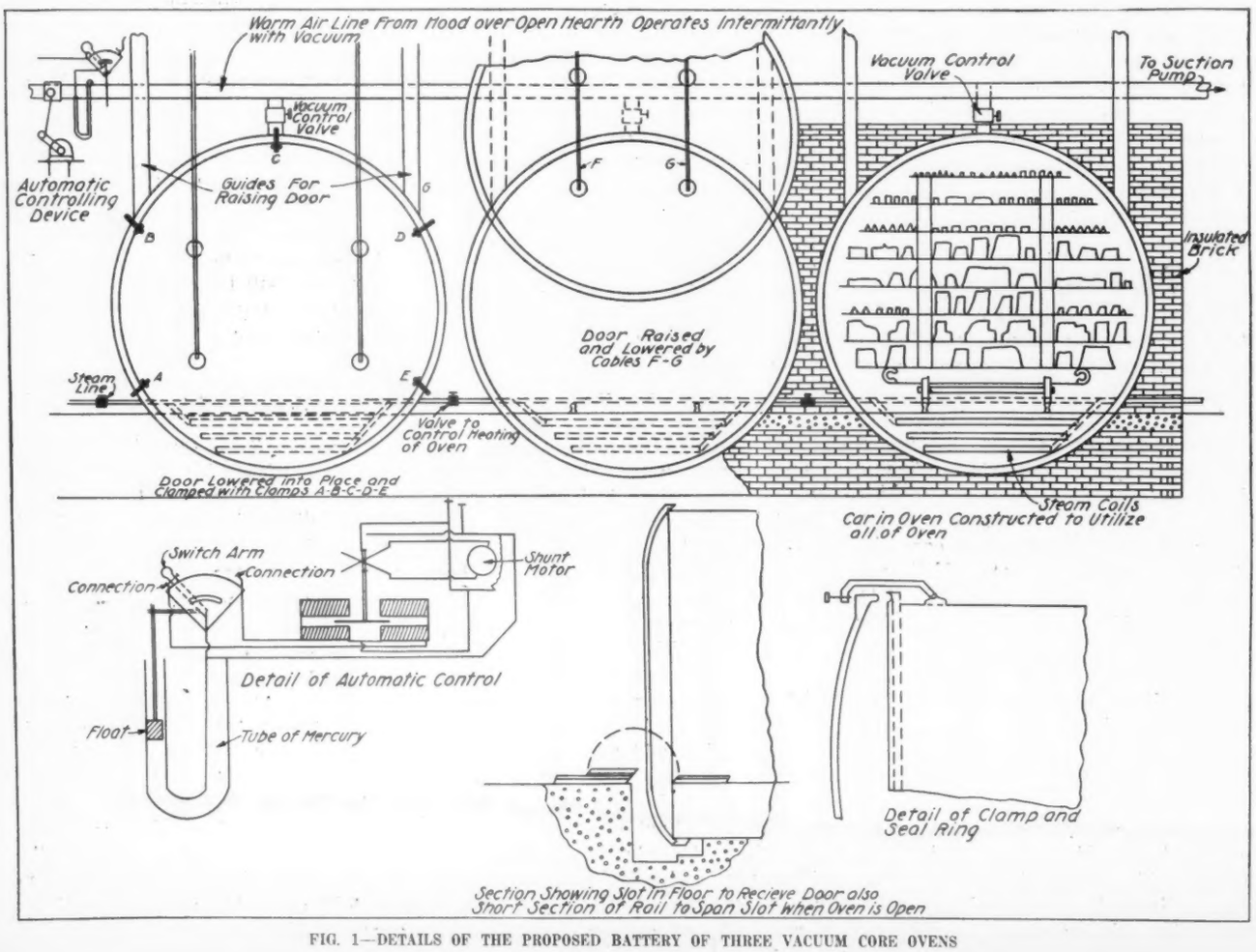

Worm Air Line From Hood over Open Hearth Operates Intermittantly with Vacuum
Vacuum Control Valve
To Suction Pump
Vacuum Control Valve
Automatic Controlling Device
Guides For Raising Door
Insulated Brick
Door Raised and Lowered by Cables F-G
Steam Line
Valve to Control heating of Oven
Door Lowered into Place and Clamped with Clamps A-B-C-D-E
Steam Coils
Car in Oven Constructed to Utilize all of Oven
Switch Arm
Connection
Connection
Shunt Motor
Detail of Automatic Control
Float
Tube of Mercury
Detail of Clamp and Seal Ring
Section Showing Slot in Floor to Recieve Door also Short Section of Rail to Span Slot when Oven is Open

FIG. 1—DETAILS OF THE PROPOSED BATTERY OF THREE VACUUM CORE OVENS

pletely dry them. This was ascertained by weighing the cores until a constant weight was reached. The only difference in the drying is that the gas-oven-dried cores had the bond more completely oxidized than the vacuum-dried cores. But as this oxidization need not necessarily take place in the oven, the time saved in vacuum drying is apparent.

Fig. 1 is a sketch of a proposed battery of three vacuum drying core ovens. They are supposed to be made of boiler steel, air-tight and of sufficient size for the purpose. The cylindrical form will withstand the atmospheric pressure without buckling, when under a high vacuum. They are to be heated by live steam which will be able to impart a temperature of 250 to 275 degrees Fahr. in the ovens. Each oven is to be connected to the main exhaust line at the back and top and can be shut-off from connection with the system, when being loaded or unloaded, by turning the connecting valves.

An exhaust pump will be connected to one end of the exhaust line and on the other end will be a rotary valve operated by a shunt motor, which will automatically open the valve when the mercury in the tube reaches a predetermined height of vacuum, by closing the circuit, operating by either the lever or floating tube control shown in Fig. 2. As soon as this valve opens, it will allow dry warm air (supplied from metal melting furnace) to be drawn into the ovens, to replace the moisture-laden air drawn out by the vacuum. When the vacuum is released by the inrush of warm air, the mercury drops in the tube to atmospheric level and closes the reverse circuit by the other contact, reversing the motor which again closes the warm air valve. While this operation is taking place, the exhaust pump is continually pumping, so that as soon as the valve is again closed the new air in the ovens is exhausted until the mercury reaches the point at which it again closes the circuit.

This operation is repeated periodically and automatically during the time of drying, causing the boiling point of the water to be lowered to approximately 115 degrees Fahr., if the maximum vacuum is brought to 26 inches of mercury. This is readily obtained in commercial drying of food, etc., by vacuum. The vapors are actually drawn out of the cores, regardless of their size, in the effort to restore equilibrium while the vacuum is increasing. When the valve is opened and warm, dry air is allowed to rush in, the vacuum spaces within the cores are filled with this air, and again is drawn out laden with the moisture vapors when the next vacuum period occurs.

One can see that the complete removal of the moisture would soon take place under these alternate conditions and would take place regardless of the size of the cores or whether they were closely-packed in the oven. In fact, the closer the oven was filled the less time it would take per unit of cores, as there would be less air space to be pumped out each turn of the vacuum.

The doors could be made of cast or pressed steel and hung on cables as shown. An air-tight joint could be made by a composition or asbestos packing ring in the outer run of the casing and the door clamped tight with the clamps illustrated. This could be quickly done after each loading. The

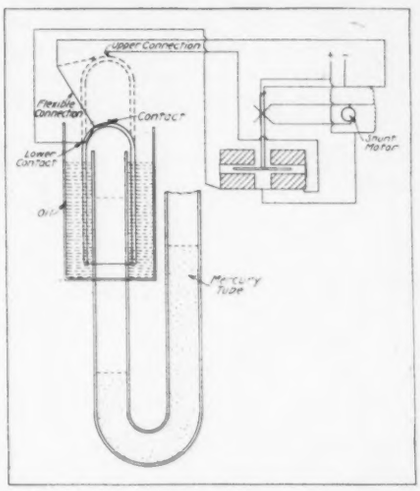


FIG. 2—DETAIL OF AUTOMATIC CONTROL FOR VACUUM CORE OVENS

doors would be swung up out of the way on the cables during the loading and unloading operation.

The ovens could be placed inside the present core ovens, using the latter as insulators to prevent loss of heat, cutting out the bottoms to bring the steam heating coils below the floor level and to allow the perforated bottom and tracks to coincide with the general floor level.

Advantages to be Attained

This drying system has been worked out with reasonable expense and the advantages are great, when the following features are considered:

Its operation is automatic and practically foolproof.

Outside the initial cost, there would be few repair costs, due to its simple construction.

The cost of heating is low.

The breakage loss, cost of labor and materials would be reduced to a minimum, as there would be no loss of strength due to the burning of the bonding material.

The maximum strength of the cores is obtained with minimum bonding material, due to *proper baking* and *thorough drying*.

The chipping room expense, caused by ragged and broken cores, leaving fins, etc., on the castings, also the metal loss for the same reason, would be largely eliminated with good, strong, sharp-edged cores.

Antimony in the Province of Hunan, China

China produces more antimony than any other country in the world and is the largest source of supply for the United States. Hunan province produces about 95 per cent of the antimony output of China, the remaining 5 per cent coming from the provinces of Kwangtung, Kwangsis, Yunnan, and Kweichow. The Hunan ores are the purest. They are reputed to be practically free from arsenic, carrying 20 to 64 per cent antimony. An effort is being made in China to concentrate the smelting of antimony ores near the place of production, and it is believed that with proper organization, the country will be able to maintain its position as the world's foremost producer of antimony. The native labor employed receives wages of 10 to 40 cents daily. The Chinese export duty is 5 per cent of the value of the product at the port of shipment. During 1918 it is estimated that the average cost of importation of Chinese metal per pound was as follows: Ocean freight, $0.025; railroad freight, $0.027; duty, $0.010; insurance, etc., $0.008; total, $0.070.

The difference between this cost and the market quotation is the margin from which must come the importer's profit and the cost of producing the metal and transporting it to the Chinese port. K. C. Li expresses the opinion that Chinese producers kept up their output in the hope of the return of the fabulous prices of the winter of 1915-16.

A considerable amount of the Chinese exports goes to Japan for refining. The amount varies with the margin afforded by the current prices in the world markets, and is reported for 1917 as 7231 tons of refined antimony.

Much of the imports by American dealers comes from the Orient through Canada. A sale of 111,751 pounds of prime Japanese antimony 99 per cent pure was held on the New York Metal Exchange on Feb. 17.

Name is Omitted

Through error, the name of the manufacturer of the sand blast helmet, described on page 236 of the April 15 issue, was omitted. This helmet is made by J. A. Spangler, Benton Harbor, Mich.

Young Brothers' Co., Detroit, manufacturer of core ovens and foundry equipment, has opened a new branch office at 708 Engineers building, Cleveland, for the purpose of more effectively serving the foundry industry of Ohio. The Cleveland office will be in charge of W. C. Wagner, district engineer.

Making a Large Piston on Emergency Order

Extemporized Patterns Were Developed Which With Care in Molding and Pouring Resulted in Complete Success—Novel Skim-Gate Was Employed

By James R Anderson

REPLACING parts, even under normal conditions, often causes costly delay in manufacturing plants. The Highland Park Mfg. Co., Charlotte, N. C., faced a more serious situation when the piston of a 2500-horsepower engine broke during a time when war demands made it impossible for the engine builder to provide a new part quickly. The Allis-Chalmers Mfg. Co., Milwaukee, in response to inquiry stated that 90 days was the minimum time which they would require to deliver the new piston. The Highland Park company owns and operates four large cotton mills that were working at that time on full production. The threatened delay meant a severe loss.

In the dilemma, the plant manager presented the problem to J. T. Beaty, superintendent of the Liddell Co., manufacturer of cotton presses and miscellaneous machinery, located in the same city. The superintendent, after consultation with his foundry and pattern shop foreman promised delivery on the part in three weeks, barring unforeseen accidents. The broken casting was delivered at the Liddell plant on Aug. 19, and the pew part was completed and ready for delivery on Aug. 31, just 12 days later. The two sectional views of the piston shown in Fig. 4 illustrates the character of the task accomplished.

Fig. 1 shows the patterns which were required. The main pattern was made from a 54 x 14-inch heavy pulley pattern with the outside lagged-up to the right diameter. The lagging extended far enough on one end of the original pulley to secure the proper thickness of the piston, which was 20 inches overall, as may be noted from Fig. 4, and in addition, to provide for an offset for the shoulder that holds the piston ring. This shoulder is shown at *B* in Fig. 4. This end of the pattern was left open. The top or cope side of the pattern was made solid. The case in which a 54-inch circular saw was shipped proved suitable for the top.

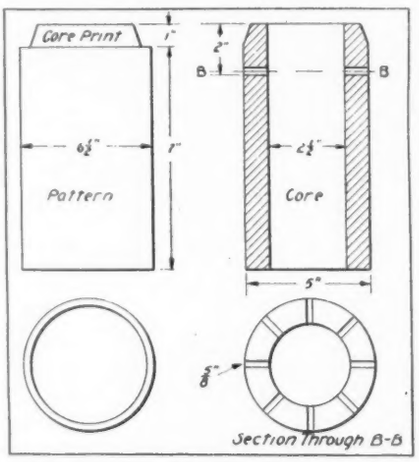


FIG. 2—PATTERN AND CORE USED IN MAKING THE SPECIAL SKIM-GATE

The main core box was made complete with a rib within the box and one-half of two other ribs on the sides. The core box shown at *D* forms one-sixth of the entire central core. Holes through each web in the casting permitted the use of spacing prints to hold the cores apart. The core arbors used were made in the form of a triangle from ⅝-inch rods, except for one rod on each side, which was made from a ¾-inch rod with eyes to engage a lifting hook for handling. Each segmental core was 17 inches thick and weighed 360 pounds.

Preparatory to making the mold, a hole was dug in the floor, 24 inches deep. In this an iron plate, 3½ feet in diameter, was placed to hold anchors fixed to the cores. A coke bed 2½ inches thick was leveled over the anchor plate. Two parallel strips of wood, 2½ inches wide, were placed on edge on the coke bed and carefully leveled. The bottom then was rammed and finished except for blacking. The mold then was ready for the patterns. The patterns were set in and sand was rammed to a height of about 5 inches from the bottom. An iron flask used to make 66-inch pulleys was then placed around the pattern. This flask had a 15-inch drag and a 6-inch cope. The drag was placed so that the top was in the same horizontal plane with the parting line of the pattern. This portion of the mold was rammed firm and a parting was made. The cope was then rammed and two pouring gates in the center, about 8 inches apart were made. These were placed so that the metal would not strike the center core in pouring. Four risers were provided in the outer edge of the mold. The cope was then lifted off and the segment pattern shown at *E* Fig. 1, was used to make the flange which holds the piston ring in place.

The pattern then was drawn and the bottom core print was centered by using a cross the size of the bottom of the mold. The core print was bedded-in at the proper place indicated by this centering. The mold then was finished and blacked, and dried with a slow wood fire.

The cores were set in and anchored in place by six anchors in the bottom

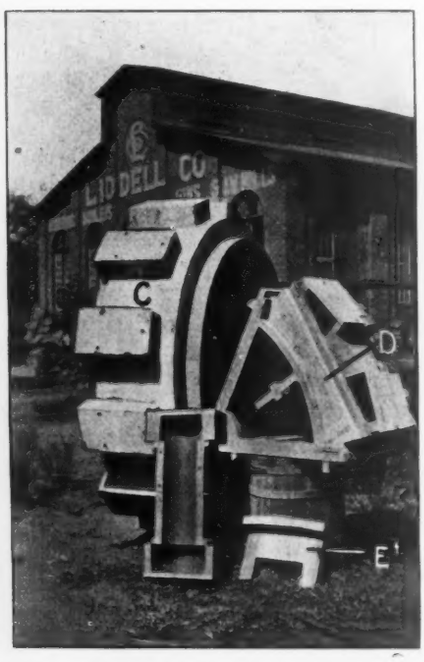


FIG. 1—PATTERNS AND COREBOXES FOR MAKING A PISTON FOR A LARGE ENGINE

FIG. 3—COMPLETED PISTON AS IT CAME FROM THE FOUNDRY

and 12 on top. The cores were placed so that the flat surfaces rested on the bottom of the mold. The mold was reinforced against upward pressure by ample weights. To prevent the weights from crushing the mold, flasks were placed at two sides and timbers laid across them to support the weights. Wedges then were placed so that any upward pressure would react against the timbers carrying the weights.

A special skim gate was used. A drawing of the pattern and core used to form this gate is shown in Fig 2. The pattern is a cylinder, about 7 inches long, with a print provided to accommodate the core. The core is about the same length as the pattern, slightly tapered at the lower end, and about ¾-inch smaller in radius than the pattern. A series of ⅝-inch holes are located about 2 inches from the bottom of this core. In using this gate, the pattern is set in a runner box over the pouring gate of the mold and rammed. A basin in which to pour the iron from the ladle is made in the runner box at one side of the point where the pattern is placed. The pattern then is drawn and the core set in place in the print left by the pattern. The core is smaller than the pattern, so that about ¾-inch metal space is left around the core. In pouring, the metal runs into the basin, overflows into the space around the core and filters through the sides of the core into the main gate of the mold. Different sizes of these gates are kept in stock by this foundry

A clean casting resulted on the first trial and machining disclosed no defects. The complete piston with M. W. Evans and A. D. Keys, the molders who did the work, are shown in Fig. 3.

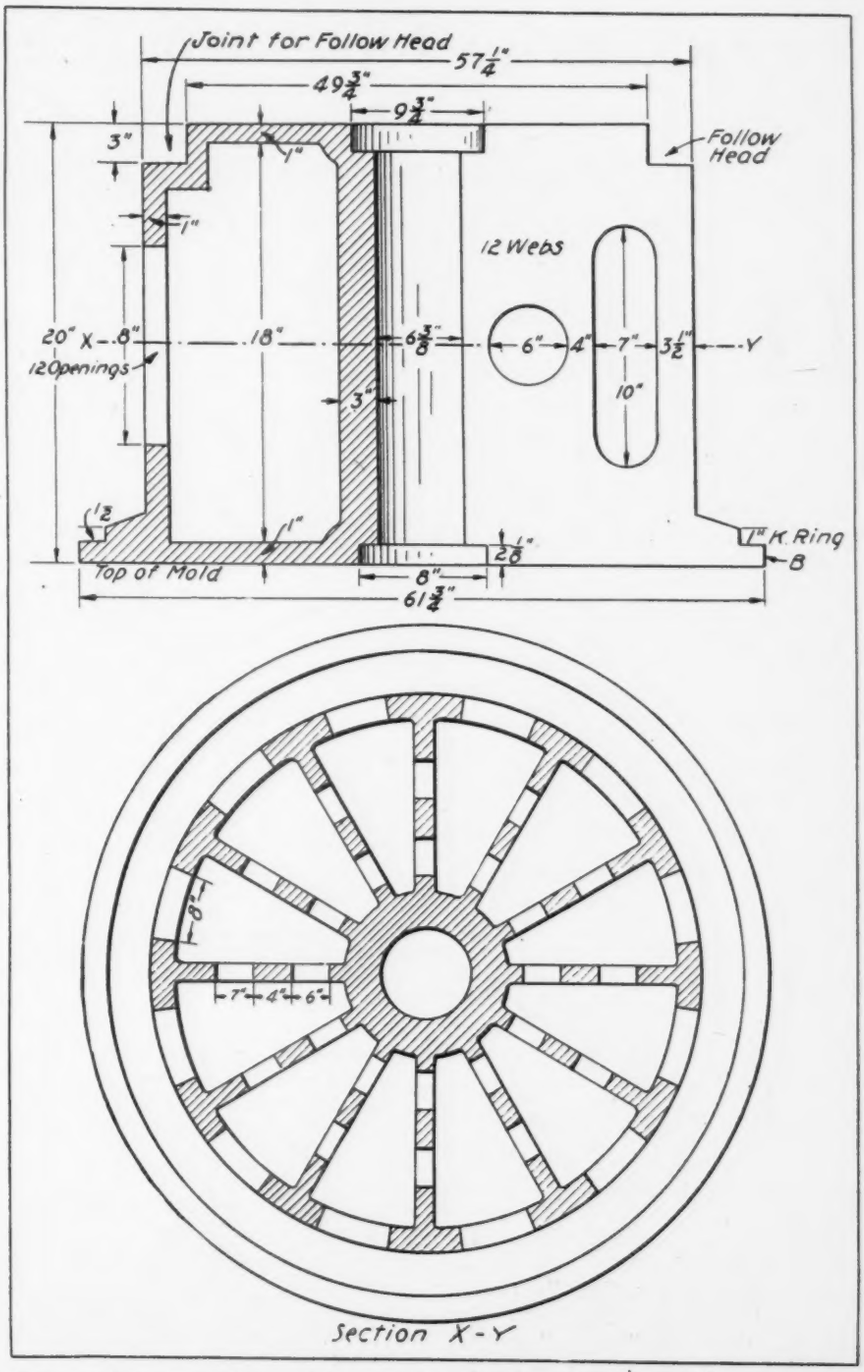


FIG. 4—CROSS AND LONGITUDINAL SECTION VIEWS OF THE PISTON SHOWING THE RADIAL WEBS, CENTER CORE AND FLANGE FOR THE RING

How German Foundries Plan for the Future

How German engineers and manufacturers propose to deal with the new difficulties of industry consequent on the war is shown by the report of the managing director of the Iron Founders' association read at the general meeting in Berlin recently.

The report says in effect that the scarcity of raw materials will continue far into the years of peace. Germany must, therefore, prepare for an intensive use of materials and human intelligence. With her instructive experience in war time in mind she must apply the latest scientific knowledge to the problems, to smelting, casting and cooling, and to the production of other qualities by the use of new alloys, and new means arising out of increased chemical knowledge. Other forms of raw material, more economical methods of burning fuel, improved construction of furnaces, more effective temperatures, all invite research and suggest progress in new directions. The Kaiser Wilhelm institute for research in iron has been founded to deal with these problems, and a sister institute for research in other metals is soon to follow. From both these the foundry industry is hoping for much help. Aluminum and zinc in their various possible combinations will replace copper and nickel and their alloys. The future importance of these metals for Germany can hardly be overrated. New forms of construction will reduce the consumption of the rarer metals for certain parts of machines. The iron founder will look to the chemist to remedy the evil of a lack of hematite. A number of German blast furnaces are already prepared to use the phosphorus-free ores of Scandinavia and other countries in place of the supposed indispensable hematite. The scientific training and the knowledge imparted in special schools must be extended and utilized. Ways have been opened to a great advance in all branches of the metal industry. Success lies in specializing and co-operation. —*Giesserei-Zeitung.*

Frank M. Erb, representing the Strong Steel Foundry Co., Buffalo, maker of open-hearth steel castings, has opened an office in the Second National bank building, Pittsburgh.

Precautions to Observe in Casting Light Work

Methods of Preventing Losses in Running Thin Castings in Brass Foundries Are Discussed and Methods of Prevention Are Suggested

By R R Clarke

No uncommon sight in light, thin work is the large number of gates with misrun castings. When 50 or 75 molds per day produce 150 to 200 pounds of castings, it is evident that casting losses must lie dangerously close to profit margins.

Thin castings fail to run because of some interference with the fluidity of the metal before the mold is filled. What these interfering causes might be is what we have to consider.

First of all liquidity and rate of congealation in the flowing metal attracts attention. Between different metals and alloys a marked difference in these two particulars exist. Pure lead becomes very fluid, flows long and far and exhibits a striking penetrating power before congealing. Not so with pure copper at the same relative temperature. Though very fluid and quite penetrating, it soon loses these qualities, once separated from the body mass. Differences between alloys are illustrated in yellow brass as compared to red brass and gun metal as contrasted with the 80-10-10 alloy. In both instances, the first named is much more liable to misrun at the same degree of fluidity.

Fluidity of Alloys Considered

Broadly speaking, alloys containing high zinc and low lead, high zinc and low tin will fail to run when those of reverse order will succeed. Aluminum is another element long delaying its congealation and perpetuating its running tendency to a remarkable extent. Carried into different alloys, yellow brass for instance, it retains this power and exercises strong control over that of the alloy. Conclusively then, the nature of the metal has much to do with the misrun casting and to get some metals or alloys to produce, imperatively suggests that they be poured much hotter. Another remarkable difference exists between new and scrap metal, the former possessing by far the better running tendency. But whatever the alloy or its quality, cold metal will not run the casting. Fluidity is the result of temperature. A casting mis-run by cold metal is a casting lost almost premeditatively. Yet there is a high temperature not conducive to the best results. Besides, there is a furnace time and temperature destructive rather than conducive to fluidity, a time and temperature whereat the metal develops abnormal dross and slag and includes them. In such condition metal is invariably sluggish. Moreover, the life of metal is its running power. To pour either too cold or too hot invites trouble. The happy temperature is that escaping the evils of both extremes.

Metal Cools in Handling

You can never pour at furnace temperature, no matter what your pouring system. In some alloys, the metal has been found to drop 100 degrees Cent. between the crucible and the mold. This signalizes the importance of rapid transportation. It is no easy task to pour, at one time, 200 pounds of metal into 30 light molds and realize 100 per cent. It is easier and better to pour 100 pounds into 15 such molds.

Pouring with the clay-lined ladle is the forced tendency of the day. The condition of the ladle is highly important. Well preheated and scrupulously clean, are prime essentials. Crusts of slag or metal from previous heats have a chilling effect. The inside shape of the ladle also has a distinct bearing on the fluidity of the metal. Keeping a ladle clean forbids too many consecutive pourings. A ladle filled and emptied four times a day will preserve cleanliness and admit longevity a hundredfold over one kept steadily at it all day long.

Before starting to preheat, ladles should be painted inside with a refractory preparation such as clay wash, red talc or plumbago, mixed in weak molasses water. This prevents crust formation. At the finish of pouring and while still hot, the ladles should be thoroughly cleaned. At the termination of pouring a furnace charge of metal into a ladle, a large amount of slag usually is in evidence. Nothing is more detrimental to either the metal or the ladle than this slag, and for this reason we consider it good practice not to drain the furnace into the ladle to this extent. To reduce slag, either in the furnace or the ladle, is to improve the metal quality and make it more limpid and live. As an aid in reducing slag, charcoal, limestone, fluorspar, oyster shells and soft coal possess a tried and recognized value. Using the same ladle to exhaust a heavy furnace charge is not best practice.

Here a word concerning preheating might be in order. A ladle properly preheated, at all points on the inner surface, shows a red to white heat, this being the result of proper combustion and correct distance of the ladle from the nozzle of the heating mechanism. Any ladle in a preheated state that shows a black bottom and red sides or *vice versa,* foreshadows difficulty in running the castings.

Molding and pouring, collectively considered, involve four conditions primarily disastrous. They are metal partition, tardiness of current, gaseous pressure and a tendency toward mold collapse. Metal partition usually originates in condition of sand, tamping, gating, pouring position and pouring method. If the sand is unduly damp or if the tamping is too severe, the metal invariably will fail to run properly. That is an outgrowth of the well-known abhorrence of metal for a damp or hard surface. No broad, thin mold unduly wet or hard rammed will run properly, no matter what the metal temperature. Gas pressure increases with mold dampness, also with sand density. Evidently, the only thing to do is to make the mold conservatively soft and yielding from well conditioned sand, and vent it generously.

Setting Proper Gates

As to gating, it might be said that no gate or set of gates that prevent the metal from entering and flowing through a mold freely can ever be trusted. Such gates deliver metal under a lateral freedom always more or less disadvantageous. Mold currents invariably conform in direction to that of the delivering gates and are proportional to the different aiding and retarding forces, so that the spread of the metal over broad, thin surfaces can be made either rapid and compact, or slow and spasmodic. Gates of volume attached to thin castings are a mistake for the simple reason that movement through them cannot be rapid from the beginning. Time taken to fill the gate and attain a hard, straight-ahead movement is sufficient to admit freezing of isolated particles of metal entering the mold in advance. Delivery gates and main runner gates should be of reduced volume and constructed with a view of avoiding angles and turning points. The casting at the end of a gate will run when, frequently, one connected by a branch gate will fail, although situated closer to the sprue. A mistake often made lies in getting the sprue of too great a diameter, preventing the rise

of the metal to the height that will generate a driving pressure. This pressure forces a rapid movement of metal much the same as the height of the reservoir increases the velocity of water from a hydrant.

Castings requiring multiple gates constitute a study. Gating to force streams of metal to unite in the mold is by far better than making the junction by metal recoil. In thin castings the latter union is seldom above suspicion. Light, flat rings, double-gated, often show an imperfect metal union at the side opposite the gates, while those gated singly, so as to send the metal swirling around in one direction only, usually escape this result.

Pouring position of the mold has much to do with metal partition. It is the common notion that metal will run best down hill, but the possibility of partition is disregarded. In an inclined mold you seldom see the metal in the sprue while pouring. That is evidence that the flow into the mold out-speeds the supply from the sprue. It is better to pour either on the level or to incline the mold slightly the other way.

Pouring Method is Important

Pouring method is equally important. It's a psychological process to pour thin castings correctly, a process in which attention, judgment, composure and control of every muscle must be at their best. Speed is requisite, but not that speed that generates excitability. Many a thin casting has laid its ruin to metal commotion in the crucible initiated by rough handling in getting from one mold to another in pouring. In starting to pour, the metal had a rocking motion which was imparted to the stream and instead of entering the sprue fairly and compactly, it slopped all around it. A similar condition arises from too great a drop from the crucible to the sprue; from the crucible not being directly over the sprue and from pouring spasmodically.

Not long ago one of our machine molders poured a heat of thin ventilator castings for ships. Practically every one was strained, involving unnecessary cleaning. We cautioned him against pouring too hard at the finish. In the next heat quite a few castings were mis-run, indicating that he erred the other way. He has the right idea now and seldom strains or mis-runs any castings. In detail, his method is to have the ladle as close to the sprue as will permit pouring, to judge about what metal it will take to fill the mold and the sprue up to about 3 inches above the top of the castings, to start pouring hard and to shut off suddenly.

Incidentally, the shape of the head of the sprue has much to do with results. If it is formed like a basin, the metal will slop in dropping into it. If it is too large, too much metal is required to fill it and get the driving pressure. The best shape is that of the oblong funnel which will catch a broad, heavy stream and at the same time fill up quickly.

Similarly, the shape or condition of the lip of the ladle or crucible is important. That giving a clean-cut, voluminous, compact stream, free from all partition and dragging of metal is the most desired.

As a means of relief, the riser gate is of prime importance in thin and expansive molds; without this gate the termination of hard pouring produces a sudden shock. Often it is expedient to have this riser gate terminate in the air at a height above the casting considerably less than that of the pouring gate, and to allow the excess metal to overflow rather than back up in the pouring gate to a straining pressure. High gate pressure is a benefit only until the metal has been compactly driven into and filled the mold after which it often becomes decidedly a detriment. Connected with results in the pouring of such molds is the great necessity of security against the run-out. We despair of every thin casting poured if attended by a run-out. When the run-out does occur, if there is any hope of saving the casting, the thing to do is to keep on pouring, regardless of the metal wasted. The drop-pouring method is perhaps the most logically efficient in driving clean metal compactly and rapidly into a mold.

Mold Collapse Discussed

The tendency toward mold collapse is another source of trouble. In a very thin mold, for instance, the sand of the cope, if not properly tamped or secured, can easily sag to the extent of meeting the sand of the drag and thus cut off the supply of metal in that vicinity. That is a natural tendency and suggests the wisdom of proper tamping and securing. For such purposes, flasks above the 14 x 16-inch size should be well barred, while those below that size should be of such a form as will retain the sand. Tamping such molds calls for good judgment. Over the pattern you dare not ram too hard, but at the same time can tamp too softly. Our most successful method has been to peen-ram hard around the flask edges and close to the pattern edge, fill the flask full of sand, tuck it down well with the finger tips and then butt-ram hard over the pattern following with generous, fine venting. On molding machine work we obtain hard side ramming by using a cleated pressing board. Broad, thin molds, approximating flask capacity, were never intended for the ordinary snap flask according to the dictates of our experience.

The collapse of the mold can come from a variety of causes. Among these are the condition of the bottom board and its seat on the drag sand surface, if concave or irregular of surface and not resting squarely against the flask edges there is always the possibility of mold sand disturbance in finally placing the cope on the drag half. From the cope half can come a similar condition in the weighting of the flask for pouring. Weights resting over the mold impression only, or those of irregular resting surface, can easily bear so hard at points as to reduce the thickness of the mold impression to stop the running metal.

Nearly all cope surfaces tamped conservatively, sag slightly when covering expansive drag impressions. For this reason we have found it good practice to strike-off the cope top surface slightly beneath the flask edge plane. We place a level plate over this plane resting on the flask edge and weight it down firmly. The slight space between the sand and this plate will just about reciprocate the sagging of the mold and give the pressure of the blowing metal an opportunity to establish a normal condition. There are some extremely thin classes of work which we have been able to get in no other way.

Condition of Flask Edges

A further menace to thin molds is the condition of the flask edges. They should be strictly true and kept clean. A cope rammed-up on a drag with sand intervening between the joints, in closing for pouring, may allow a space between those joints and the mold, under the influence of the weights, may compress enough to interfere with the metal movement. In a flask where the joints are true and clean and bear iron to iron all around, no such condition can prevail.

A final word concerning the venting of a broad, thin mold. Venting over the top, however generous, is frequently insufficient and scratching broad vents from the edge of the pattern mold to the edge of the flask is a common-sense procedure.

Initials Stated in Error

An article on brushes for foundry work published on page 211 of the April 15 issue of THE FOUNDRY was credited to J. D. Coleman. The author is F. A. Coleman, vice president and general manager of the Foundry Equipment Co., Cleveland, specialist in foundry brushes, core ovens and other kinds of foundry equipment.

The Electric Steel Co. of Indiana, Indianapolis, manufacturer of electric steel castings, has added a well-equipped chemical laboratory, located in a one-story detached building, adjacent to that part of the foundry where its electric furnace is located.

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Contents

	Page
POINTERS ON ELECTRIC STEEL FURNACE PRACTICE	239
PURCHASES FURNACE PLANT	242
DIVERSIFIED OUTPUT AT CANTON PLANT	243
COMPULSORY COSTING	250
INSTALLS FURNACE IN MEXICO	250
ESTABLISHES ST. LOUIS OFFICE	250
MAKING CASTINGS USED IN SHIP CONSTRUCTION—I	251
BILL LEARNS ABOUT THE HARDY ARGONAUTS	256
HOW PHOSPHORUS AFFECTS MALLEABLE CASTINGS	258
BOOK REVIEW	259
MAKING A SKELETON PATTERN FOR A LARGE ELBOW AND BASE	261
MELTING IN A SMALL CUPOLA WITHOUT SLAGGING	262
NEW FURNACES INSTALLED	262
METALLOGRAPHY APPLIED TO NONFERROUS METALS—III	263
HOW AND WHY IN BRASS FOUNDING	266
CASTING COPPER BARS AND WASHERS	266
ALLOYS USED FOR ALUMINUM PISTONS	266
MAKING PHOSPHOR TIN IN THE FOUNDRY	266
PREVENTING POROSITY IN AN ALL-SCRAP MIXTURE	267
ALLEN METAL MIXTURE	267
PITTING IN ALUMINUM BRONZE	267
SUBSTITUTING A CHEAPER ALLOY FOR A HIGH TIN BRONZE	267
ALLOYS FOR DIE CASTING	267
NOVEL METHOD OF DRYING CORES IN VACUUM OVENS	268
NAME IS OMITTED	269
ANTIMONY IN PROVINCE OF HUNAN, CHINA	269
MAKING A LARGE PISTON ON EMERGENCY ORDER	270
HOW GERMAN FOUNDRIES PLAN FOR THE FUTURE	271
PRECAUTIONS TO OBSERVE IN CASTING LIGHT WORK	272
INITIALS STATED IN ERROR	273
WANTED—FACTS ABOUT SAND	274
TRADE OUTLOOK IN THE FOUNDRY INDUSTRY	275
COMINGS AND GOINGS OF FOUNDRYMEN	276
OBITUARY	276
STEEL TREATERS' SOCIETY TO HOLD ANNUAL MEETING	276
BRITISH IRON AND STEEL INSTITUTE TO MEET	276
SMALL AIR COMPRESSOR IS WATER COOLED	277
USE OF MAGNESIUM IN THE FOUNDRY	277
COMBINED TRACTOR AND TRUCK FOR FOUNDRIES	278
CRANE UNLOADS STEEL BORINGS IN RECORD TIME	278
ALUMINUM INDUSTRY IN GERMANY AND AUSTRIA	278
MELTING UNIT IS INSTALLED	279
WHAT THE FOUNDRIES ARE DOING	279
NEW TRADE PUBLICATIONS	280

Wanted—Facts About Sand

NOW that American foundrymen are once more in a position to devote some thought to the fundamental problems of their industry, a scientific investigation of the sand question should be undertaken along lines which will lead to practical results. Although sand is one of the most essential raw materials used in the production of castings, foundrymen probably have given it less consideration from a technical standpoint than any other branch of their business. It should not be inferred from this statement that the progressive manufacturer does not appreciate the importance of the sand problem. A survey of the foundry literature of the past five years will show that the subject is indeed a live one, but a more critical examination of this same literature leads to the conclusion that in spite of all that has been written on the sand question by practical foundrymen, experts and others, very little tangible progress has been made toward determining in a definite way some of the many technical questions surrounding the use of sand for the production of castings. In other words, there has not been, in this country at least, the same measure of co-operation between scientists and practical foundrymen with reference to the sand problem that there has been in the study of melting, for instance. Everyone today is willing to concede that tremendous progress has resulted from the introduction of applied chemistry into the melting department. If the sand problem were approached in the same manner, enlisting the aid of practical scientists, chemists and geologists, equally startling results could be expected. There has been some scientific study of foundry sands in this country, but with one or possibly two exceptions, it has been prosecuted without proper help from practical foundrymen. As a result we have plenty of "progress reports" which are imposing to look at and take up space in the proceedings of our leading technical foundry associations, but which contain precious little information of tangible value to the practical foundryman confronted with the problem of improving the quality of his castings. This state of affairs should be remedied. We should enjoy in this country a measure of co-operation between our foundrymen, chemists and geologists, with reference to the sand problem, as complete at least as that which prevails in Great Britain. British steel foundrymen, for instance, although they have a fairly good supply of naturally bonded molding sands at their disposal, have been spending considerable money for the past two years on the scientific investigation or artificially bonded sands. Among other things, they sent one of their most eminent geologists to the United States to study the problem from the American angle in a thorough manner. Although British and European foundrymen are admittedly well advanced in their knowledge of sand and its treatment, the activity they continue to display shows they are not satisfied. Should not we on this side of the Atlantic inject a little of the well known American pep into this proposition and undertake a serious, scientific study of the sand problem as thorough as that being prosecuted by our friends and allies across the water? While this work should be undertaken from the scientific standpoint, it is equally important that it be prosecuted with the idea of producing practical results of tangible value to foundrymen in all lines of work.

Trade Outlook in the Foundry Industry

WITH but few exceptions, a slight improvement is evident in all lines of foundry activity. The Washington price controversy has had the effect of blocking actual orders, but the volume of inquiry demonstrates that substantial business awaits only the solid basis of an understood price situation. The automobile casting demand continues to be the greatest single factor in eastern and midwestern operations. Passenger car and truck builders state that the unsatisfied demand will supply capacity work far into next year. A unified effort is on foot to develop truck sales in farm communities both for use in marketing from individual farms, and to handle express and interurban freight service. This field, which is practically untouched, promises to be tremendously important with the favorable factors of excellent crop conditions and high produce prices prevailing in rural communities.

Steel is Quiet

Those steel shops which are dependent to a great extent upon railway castings are slack. No immediate hope is held out for work from this direction, although it is universally admitted that the need for replacements is acute. An order for some 5000 cars for the Italian government has been held in abeyance in the Detroit district pending the adjustment of the Hines-Peek deadlock. This will no doubt be supplemented by a certain amount of locomotive work which is expected both from the Italian and French railways. Tractor parts are engaging those steel foundries which are a part of the larger factories, and jobbing business in these lines is active. The manufacture of electrical equipment is below average, but export business is expected, which with general increase in demand should form a peak load for foundries on this class of work before the end of the year. The volume of passenger car manufacture is reaching unexpected heights, and is furnishing a steady demand for light steel castings, furnishing work for jobbing shops.

Malleable Climbs

Definite figures are not available on malleable production, but the trend indicates that the average is above the 70 per cent operation which prevailed during the month past. The automobile trade which furnishes a large volume of business provides the backbone for a strong inquiry. Implement manufacture still is hampered, but with the advancing season every indication points to increasing activity. This taken with the railroad buying will ultimately reinforce the automobile requirements and should form an exceptionally strong demand. Miscellaneous machinery castings are not in heavy demand, nor are electrical equipment parts and line material. Pipe fittings, however, and tractor parts provide a fair amount of business of a stable nature.

Gray Iron Varies

Tangent as it is with practically every circle of productive activity gray iron at present is subject to a variety of fortunes. The machine-tool industry which has been influenced to some degree by the amount of used equipment available is for the most part inactive. However, those builders who have holdover orders for tools for government use, and those who qualify on special classes of work are working nearly to capacity. Foundries furnishing castings for makers of standard tools are engaged at less than 50 per cent. The development of business abroad is foretold by several inquiries for tools adapted to railroad shop work. Stove and furnace manufacturers report inquiries, and the iron sold to foundries engaged on this class of work indicates increasing activity. One stove foundry is reported as buying heavily into the third quarter. Makers of pipe fittings are benefited by healthy and increasing requirements throughout the oil well localities. Cast-pipe still is reluctant, though southern makers are operating well toward capacity. The slowness in this class of foundry product is attributed to the fact that the smaller municipalities are not buying. Where the price of pipe will not deter one of the larger cities from making needed extensions, the smaller centers are canny and are awaiting cheaper materials and labor. The great volume of pipe business comes from the smaller communities. Marine-engine building continues to employ a large number of foundries, although some suspensions are reported.

Prices of Raw Materials for Foundry Use

CORRECTED TO APRIL 25

Iron		Scrap	
No. 2 Foundry, Valley	$26.75	Heavy melting steel, valley	$16.00 to 16.50
No. 2 Foundry, Birmingham	26.75	Heavy melting steel, Pbgh.	15.50 to 16.00
No. 2 Foundry, Chicago	26.75	Heavy melting steel, Chicago	16.00 to 16.50
No. 2 Foundry, Philadelphia	30.65	Stove plate, Chicago	18.25 to 18.75
Basic, Valley	25.75	No. 1 cast, Chicago	23.00 to 24.00
Malleable, Chicago	27.25	No. 1 cast, Philadelphia	21.00 to 22.00
Malleable, Buffalo	27.25	No. 1 cast, Birmingham	18.00 to 20.00
Coke		Car wheels, iron, Pittsburgh	24.00 to 25.00
Connellsville foundry coke	4.50 to 5.50	Car wheels, iron, Chicago	20.50 to 21.50
Wise county foundry coke	6.00 to 6.50	Railroad malleable, Chicago	18.50 to 19.00
		Agricultural malleable, Chicago	17.25 to 17.75

Nonferrous is Slow

Allied closely as it is with steel prices, the brass and aluminum casting industry is not extremely active. The cessation of airplane work and the transition back to prewar lines would have had little effect were it not for the sluggishness imparted by the iron and steel price tangle. Shops making valves and fittings, and those furnishing bearings for the tractor and automobile lines continue near full operation. Aluminum motor parts, too, furnish a steady activity, while ship fittings, engine bronzes, etc., for marine use bolster up yet another class of nonferrous casting plants. Casting copper is quoted at 15c to 15½c, New York. Prices on other nonferrous metals based on New York are as follows: Lead, 5c; tin, 72½c; antimony, 6.75c; aluminum, No. 12 alloy, producers' price, 33c, and open market, 25c to 25.5c. Spelter is quoted 6.05c to 6.07½c, St. Louis.

COMINGS AND GOINGS OF FOUNDRYMEN

William L. Heppner has been made foreman of Clark Brothers Co., Olean, N. Y., manufacturer of engines, air compressors and saw-mill machinery.

J. C. Green has been made president of the newly organized Pattern & Castings Product Co., Saginaw, Mich., manufacturer of brass and aluminum castings.

Harvey L. Barnard, formerly with the United Alloy Steel Co., Canton, O., has entered upon his duties as superintendent of production at the plant of the Pittsburgh Crucible Steel Co., Midland, Pa.

W. C. Wagner has been appointed district engineer in charge of the new branch office which has been established at 708 Engineers building, Cleveland, by Young Brothers' Co., Detroit.

Guy L. Street, formerly superintendent of the Michigan Motor Castings Operating Co. of the Buick Motor Co., Flint, Mich., has been appointed general foreman of the American Foundry Co., Indianapolis.

A. U. Wetherbee, recently discharged from the service as captain in the chemical warfare branch, has accepted the position of chief engineer for the Powdered Coal Engineering & Equipment Co., Chicago.

Leo G. Smith has accepted the position of general manager for the Modern Steel Casting Co., Milwaukee. His steel foundry experience covers a number of years during which he was in charge of plants in the United States and Canada.

James H. Anderson, who has been with the C. S. Bell Co., of Hillsboro, O., as foundry superintendent for the past 12 years, has resigned to become general superintendent for the Root-Heath Mfg. Co., Plymouth, O.

Thomas Liesk, formerly with the Power & Mining Machinery Co., Cudahy, Wis., has been made foundry superintendent for the Busch-Sulzer Diesel Engine Co., St. Louis, and will have charge of the new gray iron foundry now under construction.

S. H. Moon, formerly connected with the Louisville, Ky., plant of the Standard Sanitary Mfg. Co., and later secretary and treasurer of the company, has been elected vice president to succeed the late Francis J. Torrance. M. C. Wilde, assistant secretary and treasurer, is acting as secretary of the company.

W. H. Woodin, president, American Car & Foundry Co., and C. P. Coleman, president, Worthington Pump & Machinery Corp., were chosen to serve on the board of directors of the newly organized American-Roumanian chamber of commerce, which has been organized to develop opportunities coincident with the reconstruction of Roumanian industrial and commercial activities.

G. C. Conklin, who for a number of years was connected with the factory of the Oliver Machinery Co., Grand Rapids, Mich., has been appointed district sales manager in charge of the Chicago office. George C. Ramer, formerly in the St. Louis office of the same company, has been transferred to Chicago.

George Cory Sr., formerly with the Allis-Chalmers Co., Milwaukee, has been made superintendent of the foundry and pattern shop at the Harrison, N. J., plant of the Worthington Pump & Machinery Corp. William G. Ferber has accepted the position of general foreman at the same plant.

Bernard A. Drewes has resigned as foundry superintendent of the Milwaukee plant of the Avery Co., Peoria, Ill., in Milwaukee, to accept a similar position with the Kissel Motor Car Co., Hartford, Wis., which has enlarged its casting shop. G. H. Jones succeeds Mr. Drewes at the Avery foundry.

F. W. Sinram, vice president of the Van Dorn & Dutton Co., Cleveland, was re-elected president of the American Gear Manufacturers' association at its recent meeting in Cleveland. William Ganschow, William Ganschow Co., Chicago, E. J. Frost, Frost Gear & Forge Co., Jackson, Mich., and J. B. Foote, Foote Bros. Gear & Machine Co., Chicago, were elected members of the executive committee.

OBITUARY

Ernest Law, member of the firm of Ernest Law & Co., Philadelphia, pig iron, steel and coke merchants, died at his residence in St. Davids, Pa., on April 4. Mr. Law was a graduate of the University of Pennsylvania.

George D. Sheriffs died at his home in Milwaukee on April 18. Mr. Sheriffs was secretary of the Western Malleable & Gray Iron Co., Manitowoc, for a number of years, and until quite recently was president of the Sheriffs Mfg. Co., Milwaukee, maker of propeller wheels. He was born in Milwaukee in 1869 and throughout his life was active in public work, serving as deputy clerk of courts, supervisor, and secretary of the West Milwaukee school board.

J. Vance Roller, metallurgist for the United Engineering & Foundry Co., Pittsburgh, died at the West Penn hospital in that city on March 29. He had been engaged in his present position for the past 15 years, prior to which time he was metallurgist at the Edgar Thompson works of the Carnegie Steel Co.

J. F. Durbin, vice president of the Durbin Foundry Co., East St. Louis, died at his home in that city on April 10. He was active in the foundry business for many years, but retired last November when his health failed.

Stanley Griswold Flagg, a pioneer in the manufacture of malleable iron fittings, died recently at his home in Philadelphia. Mr. Flagg, who was 89 years old, retired from the firm of Stanley G. Flagg & Co. eight years ago, after a continuous activity in the malleable manufacturing business since 1855. He started his first plant in Frankford, Pa., in 1855. Following this, in 1860, he built a foundry in Philadelphia which became the nucleus for the present large establishment. In 1872 he added to his business the manufacture of stove lining and firebrick through the purchase of a pottery in his home city. He is survived by his sons, Stanley Griswold Flagg Jr. and George Flagg, who with a grandson, Stanley Griswold Flagg III, are associated in the business of their father.

Steel Treaters' Society to Hold Annual Meeting

The first annual convention of the American Steel Treaters' society will be held in Chicago during the week of Sept. 22. This organization, which numbers chapters in Chicago, Philadelphia, Pittsburgh, Cleveland and Milwaukee, plans to establish a laboratory for the study of technical problems. The headquarters of the society are at 154 East Erie street, Chicago. A. G. Henry, metallurgist, Illinois Tool Works, is secretary-treasurer.

British Iron and Steel Institute to Meet

The annual meeting of the British Iron and Steel institute will be held in London May 8 and 9. The president of the institute, Eugene Schneider, head of the great French ordnance firm will act as chairman. The feature of the opening session, Thursday, May 8, will be the award of the Bessemer medal for 1919 to Professor Federico Giolitti, of Turin, Italy. On the afternoon of the opening day a joint session will be held with the Institution of Electrical Engineers at which papers on electric steel furnaces for foundry use will be read and discussed.

At the opening session Friday

morning, May 9, the award of grants from the Andrew Carnegie Research fund in aid of research work will be announced. A large number of important technical papers will be presented at the Friday afternoon meeting. The program this year includes 17 papers on a variety of timely subjects.

In celebration of the jubilee of the foundation of the Iron and Steel institute in 1869, the annual dinner will be held Friday evening, May 9, in the Guildhall of the City of London.

A Pyrometer for Brass Melters

In designing pyrometers for measuring the temperature of molten brass two conditions must be met. In the first place a quick reading is necessary because the hot metal cannot be delayed in its journey from the furnace to the mold without injury from oxidation, excessive cooling, etc. At the same time all parts of the instrument must stand up under ordinary foundry use. In the case of thermocouple pyrometers, the first condition demands a thin-walled protection tube in order that the instrument may respond quickly when plunged into the molten metal. But to meet the second condition the tube must successfully withstand the action of the hot material as well as general foundry wear and tear.

These more or less contradictory requirements, it is now claimed, have been met in a new pyrometer developed by the Hoskins Mfg. Co., Detroit, which is provided with a protection-tube made of a new alloy of chromium and iron. This alloy, it is said, withstands satisfactorily the action of all types of brass and all classes of bronze except those high in phosphorus.

FIG. 1—USING THE PYROMETER

The importance of being able to determine pouring temperatures in the production of brass and bronze castings is appreciated by all progressive nonferrous foundrymen.

Fig. 1 shows how this pyrometer is used. The tube, as shown in Fig. 2, consists of three parts. Section *B* telescopes into the upper end of the seamless steel tube *D*. The protection tube proper, marked *C*, is held in the lower end. This tube, which is 10 inches long, is made of the new alloy. The thermocouple *A* is entirely encased in the tube and can be easily renewed.

The alloy tip and the thermocouple are the only parts which need renewal. When the alloy tube is ultimately destroyed it can readily be removed and a new one installed. A shoulder is cast on the upper end of the tip which engages in the collar shown on tube *D*. The protection tube is held in place by giving it a half turn, packing the connection with a special refractory cement.

If the tube is used to complete destruction, or to a point where the molten metal can reach the thermocouple, then

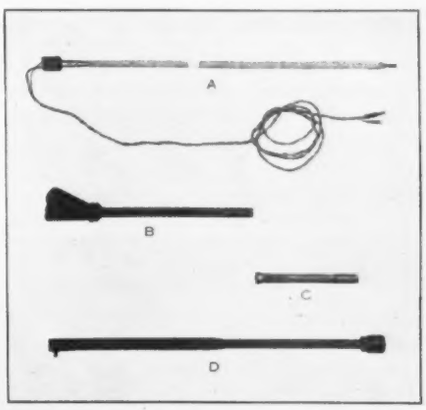


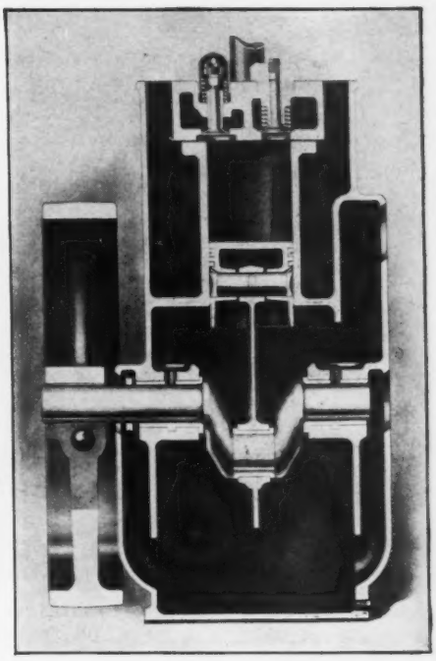
FIG. 2—THE PARTS OF THE PYROMETER

the latter has to be repaired. This is done by cutting off the damaged part and twisting and rewelding the wires. This can be repeated until the couple reaches a length of 3½ feet when it must be renewed. The couple, however, can be changed end for end. The unwelded end can be welded and used at the hot end.

Small Air Compressor is Water Cooled

A small air compressor developed during the war has now been placed upon the market. It is manufactured in four sizes ranging from 3 to 45 cubic feet per minute at 100 pounds per square inch, and it is claimed it may be used for pressure requirements up to 200 pounds per square inch by slightly increasing the driving horsepower.

This compressor is a single-acting



SECTION OF COMPRESSOR WITH WATER COOLING

machine of the vertical type and is built for belt drive, as is shown in the accompanying illustration. It is said that the machine is so well balanced that it will operate satisfactorily when bolted to any solid flooring. The smallest size is built with a ribbed cylinder for air cooling where the service is intermittent and with a water-cooled cylinder of the reservoir type where the service is continuous. The larger sizes are all water-cooled with the reservoir jacket system except that a closed jacket for connection to the pressure system is sometimes omitted. This connection affords ample water capacity to cool both cylinder barrel and head. It is stated that one filling of the water space is sufficient for a 10-hour run.

In general the design resembles an automobile engine with its drop-forged crankshaft and connecting rod, die-cast renewable bearings and automatic splash lubrication system. This compressor is manufactured by the Ingersoll-Rand Co., New York.

Use of Magnesium in the Foundry

Next to silicon, aluminum and calcium, magnesium is the most common of metals. It is found in a great variety of forms and in many of the common minerals. Prior to 1914 most of the magnesium used in this country was imported from Germany. However, since that time a large plant for the recovery of this metal has been developed by the Shawinigan Electric-Metals Co., Ltd., at Shawinigan Falls, Province of Quebec, Can. The main office of the company is at Montreal and the sales office

THREE-WHEEL TRUCK WITH END-DUMP BOX BODY FOR USE IN HANDLING MATERIALS ABOUT THE FOUNDRY FLOORS

in the Leader-News building, Cleveland.

An instruction booklet containing 32 pages, which will prove of value to foundrymen and others employing magnesium in its various forms has recently been issued by the Shawinigan company. Every application of magnesium described is practiced in some foundry. A chapter also is devoted to helpful hints for those endeavoring to make special alloys to meet unusual needs.

Combined Tractor and Truck for Foundries

The Clark Tructrator Co., Chicago, has developed the industrial motive unit which is shown in the accompanying illustration. This is a three-wheel car driven by a four-cylinder, 3⅛ x 4½-inch motor located at the rear, and connected through a multiple disk clutch, three-speed transmission and drive shaft to the front axle. The standard automobile control is used, and the car is steered through a worm and sector type gear to the single rear wheel. The box-bed, dump car or loading platform, as may be specified, is located in front of the driver. Special types of dump boxes are provided for different industrial uses. The type illustrated has an end dump mechanism which permits sand to be handled from the heap directly to the molding floor. The same dump box is convenient for handling light castings and transporting them to the finishing room. Other materials may be moved about the foundry in a similar manner. A rear coupler, back of the driver's seat, makes the unit available for tractor purposes in hauling trucks or small cars about the plant. The short wheel-base and single guide wheel permit easy turning in limited space. The length over all is 72 inches and the tread is 35½ inches. Gasoline is used for fuel and economical operation is claimed.

Crane Unloads Steel Borings in Record Time

In the accompanying illustration is shown an 8-wheel, 10-ton electric locomotive crane and bucket designed by the Orton & Steinbrenner Co., Chicago, to handle metal borings and turnings. The bucket is of the V-shape, clam shell type and has a capacity of about one yard. The crane may be switched around the plant by means of either a steam or electric locomotive or when the cable is connected to the power circuit, the crane may move to either limit of its cable length. This crane is installed at the plant of the National Acme Co., Cleveland.

It is claimed that the crane and bucket handles borings and turnings to good advantage specially in plants where a magnet may not be available. A carload of material, it is said, has been unloaded in one hour's time by this crane.

ELECTRIC CRANE AND BUCKET FOR HANDLING BORINGS

Aluminum Industry in Germany and Austria

In 1913 Germany used 12,500 tons of aluminum, of which 10,000 tons were imported from France and Switzerland. Today Hungary and Carniola supply sufficient bauxite to satisfy the requirements of the central powers. The regions of the Ida and of the Zud furnish considerable quantities of bauxite, comparable with the French bauxite. This deposit is being worked by a company with a capital of 3,000,000 kroner, with the aid of the General Hungarian bank, and in 1915 produced 59,000 tons of bauxite. The deposits at Vojelsberg, Hesse, are

worked by the Obermayer Co., Hanover; the workings of Rudnika are being reopened, the deposits of Bihar and Kolosz supply bauxite to the Swiss factories and to the German factory of Goldschmieden-Troltra and to the Marius factory near Cologne. The pure aluminum is sent on to the Swiss factories of Neuhausen, Rheinfelden, Lend, and Chippis. The product of these factories is returned to Germany, with the exception of a proportion reserved for Switzerland. A Bavarian company, the Bayerische Aluminum Werke, was founded in 1916 with a hydroelectric installation at Mühldorf on the Inn, with a capacity of 55,000 horsepower, capable of supplying one-third of the total requirements of Germany. An important factory has been built recently in Dalmatia.

This enterprise is supported by three large Viennese banks, by the Berndorfer Metallwarenfabrik A. Krupp, the industrial magnate Bernhard Wetzler, and the Hydraulic Power Co., of Kerka.—*Revue générale de l'Electricité.*

Melting Unit is Installed

The Electric Furnace Construction Co., Philadelphia, has installed a Greaves-Etchells furnace at the plant of the Davidson Tool Mfg. Corp., Brooklyn, N. Y. This furnace is used in conjunction with a special process for casting high-speed steel.

Scully, Jones & Co., Chicago, are making preparation to manufacture a complete line of foundry equipment at Bedford, Ind.

WHAT THE FOUNDRIES ARE DOING

Activities of the Iron, Steel and Brass Shops

The Industrial Foundry Co., St. Johns, Mich., is installing a 7½-ton crane.

Michael Hayman & Co., Buffalo, will build a foundry, 80 x 100 feet.

A. J. Drews, Roseburg, Oreg., in addition to his machine shop is adding to it a foundry.

John Collins, Marysville, Cal., is reported planning to build a foundry and machine shop.

The Commercial Foundry Co., St. Louis, recently let contracts for the construction of a plant.

The Central Foundry Co., Saginaw, Mich., is rushing to completion work on its new plant.

The American Skein & Foundry Co., Racine, Wis., contemplates the erection of a plant addition.

Hedderich Bros., 405 Bond street, Evansville, Ind., will erect a brass foundry, 50 x 100 feet.

The International Malleable Iron Co., Ltd., Guelph, Ont., will erect a plant, 60 x 160 feet.

The Otto Biefeld Co., Watertown, Wis., plans to build a foundry.

The Lloyd Garrett Co., Philadelphia, recently awarded Mitchell Bros. a contract to erect an addition to its foundry.

An enlargement to the plant of the Fay-Kultgen Foundry Co., St. Joseph, Mich., will be undertaken shortly.

James Smith, 1009 Stanford avenue, Los Angeles, plans to erect a foundry, 24 x 50 feet. Plans have been drawn.

The Central Foundry Co., 90 West street, New York, contemplates erecting a warehouse. Plans are in a preliminary stage at present.

A brick and steel foundry addition is now under erection at the plant of the J. W. Pohlmann Foundry Co., Baltz avenue, Buffalo.

Plans are being completed for the erection of an addition to the plant of the American Malleables Co., Lancaster, N. Y.

Excavation work for a proposed addition, 100 x 800 feet, has been started at the plant of the Wilson Foundry & Machine Co., Pontiac, Mich.

Emil D. Aras, 705 North Hancock street, Philadelphia, plans the erection of a foundry addition, 20 x 30 feet. The general contract has been let.

The Allyne-Ryan Foundry Co., 8904 Aetna road, Cleveland, has let a contract for the erection of a core room addition, 70 x 100 feet.

The Williamson Foundry Co., Marburg avenue, Cincinnati, is reported planning the erection of a plant addition, 60 x 90 feet.

The Hudson Valley Foundry Co., Kingston, N. Y., recently was incorporated with $5000 capital, by J. J. and D. J. Murphy and W. A. Roedell.

The Superior Iron Works, Superior, Wis., plans the erection of an addition to be used for foundry purposes. Frank F. Hayes is president of the company.

William Kennedy & Sons, Ltd., 1114 First avenue, Owen Sound, Ont., is reported planning to build a 30 x 46-foot foundry addition.

The Chester Iron Co., Curtis and Vulcan streets, St. Louis, is reported planning the construction of a machine shop and foundry.

The erection of an addition is contemplated by the Finch Mfg. Co., Scranton, Pa., manufacturer of brass and steel castings.

The Benton Harbor Malleable Foundry Co., Benton Harbor, Mich., is installing a testing laboratory. H. C. Campbell is chief chemist.

The Lorain Brass & Bronze Foundry Co., Lorain, O., recently increased its capital from $2000 to $10,000.

The H. M. Morse Co., architects, 413 Citizens building, Cleveland, is preparing plans for the erection of a plant for the Plate Foundry Co.

Plans have been drawn for a pattern storage building for the Gleason Works, 1000 University street, Rochester, N. Y.

A recent increase in capital from $20,000 to $100,000 was made by the Kenney Foundry Co., Mansfield, O.

The Austin Co., Cleveland, is taking bids for the construction of a foundry, 70 x 144 feet, for the Philadelphia Sash Weight Works, Philadelphia.

A contract has been let by the Springfield Foundry Co., Springfield, Mass., for the erection of an addition, 87 x 100 feet.

Contractors have started erection of a foundry, 100 x 450 feet, for the Holmes Foundry Co., 2863 Twenty-eighth street, Port Huron, Mich.

The Detroit Copper & Brass Rolling Mills, Detroit, is reported planning the construction of a casting plant.

A contract has been let by the American Gas Machine Co., Albert Lea, Minn., for the construction of a foundry.

Work has been started on the erection of a small addition, 50 x 75 feet, by the Western Steel Car & Foundry Co., 37 West Van Buren street, Chicago.

The Wheeling Mold & Foundry Co., Wheeling, W. Va., has started on the erection of an addition, 300 x 350 feet.

The American Malleable Co., Lancaster, N. Y., has completed plans for the erection of an addition to its plant.

The Keystone Iron Works, 959 North Main street, Los Angeles, will construct plant additions, which will include a foundry.

The Jones & Hopkins Mfg. Co., Nashville, Tenn., has disposed of its foundry to the Naive-Spillers Co., and plans to enlarge its main building.

The Canada Metal Co., Ltd., 35 Fraser avenue, Toronto, Ont., is building a plant at Halifax, N. S., consisting of a brass foundry and a rolling mill.

Additional equipment for its proposed machine shop and foundry will be purchased by the National Machine & Electric Co., High Point, N. C. T. G. Shelton is secretary.

Work has started on the construction of a plant for the Newport Foundry Co., Newport, Ark. The building will be 70 x 110 feet. The company was recently incorporated with $50,000.

The Pattern & Casting Products Co., Saginaw, Mich., will open a new plant at 217-219 North Water street, Saginaw, shortly. J. C. Green is head of the company.

The Anderson Standard Brass Foundry Corp., Anderson, Ind., has been incorporated with $20,000 capital, by G. A. Robinson, William H. Bronenberg and Walter Vermillion.

A contract has been let to Stone & Arthur, 2055 Amber street, Philadelphia, for a foundry, 48 x 103 feet, for the William Cunnings Co., 1615 North Second street, Philadelphia.

The Southern Foundry & Machine Co., Chattanooga, Tenn., recently was incorporated with $75,000 capital, by Will Cummings, W. J. Cotter, E. H. Williams, James H. Anderson and T. Pope Shepperd.

A brass foundry and machine shop will be erected by the Pioneer Brass Works, Indianapolis. J. H. Brinkmeyer, 418 South Pennsylvania street, is president of the company.

The Wabash Foundry Co., Wabash, Ind., which at present operates a 20-ton gray iron jobbing foundry, will within the next 60 days erect an addition to its molding room which will double its present capacity.

The Atlas Foundry Co., 234 Artillery avenue, Detroit, will erect a molding room addition. Robert Crawford is president of the company, which specializes in the manufacture of automobile castings.

Articles have been filed with the secretary of state announcing an increase in capital from $10,000 to $45,000, recently made by the Johnston Casting & Mfg. Co., Brooklyn, N. Y.

Fire recently damaged the plant of the Marion Machine, Foundry & Supply Co., Scottdale, Pa. The loss was estimated at $25,000. The plant is being repaired.

The plant formerly occupied by the Dilley Foundry Co., Pine Bluff, Ark., has been purchased by the Standard Lumber Co., which plans to erect a large warehouse on the site.

Frank J. Quinn, Palmer, Mass., Frank L. Quinn and F. S. Mills, recently incorporated the Ware Foundry Co., Ware, Mass. The company is capitalized at $10,000.

Plans are being revised for the erection of a foundry, 102 x 227 feet, for the Defiance Machine Works, Defiance, O. Bids will be taken shortly for equipment.

The Taplin-Rice-Clerkin Co., Akron, O., is re-

ported having obtained options on several pieces of property on which it contemplates erecting a foundry in the future.

The Polish American Foundry Co., Buffalo, has been incorporated with $50,000 capital, by S. Marciniak, 580 Amherst street, W. L. L. Gbowacki, 357 Amherst street and W. Kajac,. 586 Amherst street.

The Keystone Axle Works, Pittsburgh, has sold its property to the Pittsburgh Malleable Iron Co., Thirty-fourth and Smallman streets. The buildings will be remodeled.

A building permit has been issued to William J. Garvey, 4916 Bloomingdale road, Chicago, for the erection of a 1-story, 50 x 80-foot addition to his foundry.

The E. H. Bardes Range & Foundry Co., Cincinnati, is having plans prepared for the erection of an addition to its foundry. E. H. Bardes is president of the company.

The Foster Brass Foundry, Cedar Rapids, Iowa, is equipping the old plant of the Tokheim Mfg. Co., which it will utilize for a foundry, 50 x 110 feet. W. H. Dutton is interested in the company.

Frank D. Chase, Inc., Chicago, engineer, has prepared plans for the Saginaw Malleable Iron Co., Saginaw, Mich., which contemplates the construction of a core building and malleable plant. Bids are being taken.

The John Whitfield Co., Ltd., Toronto, Ont., has been incorporated to operate an iron foundry and manufacture chains, etc., with $250,000 capital. The incorporators are Edward L. Middleton, John H. Beckington and others.

A group of buildings will be erected at the plant of the Riverside Steel Castings Co., Newark, N. J.

Plans are under way for repairing a part of the foundry of the Perseverance Iron Foundry, Philadelphia, which was recently damaged by fire.

A recent Indiana incorporation is that of the Connersville Foundry Corp., Connersville, Ind., which is capitalized at $300,000. The incorporators are F. I. Barrows, Frank M. Tatman, Joseph A. Braun and Arthur Dixon.

Walter K. Greenbaum, Leon N. Kramer and Edward A. Simpson are the incorporators of the Michigan City Foundry & Machine Co., which has been incorporated at Michigan City, Ind., with $50,000 capital.

The Lansing Co., Lansing, Mich., has resumed building operations which were abandoned during the war. Plans call for a building, 60 x 200 feet to be used for sheet steel storage. A core room also will be erected.

The Iowa Steel & Iron Works, R. T. Hartman, vice president, 412 Twelfth avenue, Cedar Rapids, Iowa, has let a contract to the John Klepach Construction Co., 1123 South Third street, for the erection of a foundry addition, 40 x 80 feet.

The Cedar Rapids Foundry & Machine Co., R. Lord, president, 901 Second avenue, Cedar Rapids, Iowa, has let a contract to John Leasure, 326 Dows building, for the erection of a foundry addition, 64 x 95 feet.

Contracts for the new foundry building for the Busch, Sulzer Bros. Diesel Engine Co., St. Louis, have been let to the Austin Co., Cleveland. All heavy equipment has been purchased. Heavy and semi-heavy gray iron engine castings will be produced.

Nordyke & Marmon Co., Kentucky avenue and Morris street, Indianapolis, will convert one of the large machine shops erected during 1918 into a modern gray iron foundry. Equipment will be purchased shortly.

A recent New York incorporation is that of the J. W. Richardson Foundry & Metals Corp. The company is capitalized at $15,000 and was incorporated by J. W. Richardson, T. F. Vandorn and M. Halsted, 400 West 151st street.

A recent Alabama incorporation is that of the National Grate Bar Co., American Trust building, Birmingham, which was incorporated to operate a foundry and machine shop. The incorporators are W. L. Rosamond, H. E. McCormack and R. D. Curry.

The Union Steel Products Co., Albion, Mich., is erecting an addition to its gray iron foundry and also an office building. The company is purchasing various classes of equipment, including machine tools, foundry equipment, sheet metal working machinery, electrical apparatus, etc.

Quinlan & Robertson, Inc., has been incorporated as tool makers, metal workers, brass founders, etc., with $50,000 capital. The incorporators are F. G. Grimmel, Newark, N. J.; C. M. Clark, 601 West 141st street and F. W. Marquard, 469 Macon street, Brooklyn, N. Y.

The Charles Bohn Foundry Co., 738 Hart avenue, is having plans drawn for the erection of a power house. The company recently let a contract to Charles Reisford, 753 Greenwood avenue, for the construction of an aluminum and brass foundry, 168 x 240 feet.

Negotiations have been closed by the Falls Mine Car & Equipment Co., Beaver Falls, Pa., for the purchase of a four-acre tract near New Galilee, Pa. The company plans to erect a new car plant and foundry on the site. H. R. Beagle is an officer of the company.

Plans have been completed for the erection of a foundry for the Muskegon Tool & Stamping Co., Muskegon, Mich. The building will be 45 x 80 feet.

The Joubert & Goslin Machine & Foundry Co., Ninth avenue and Thirty-sixth street, Birmingham, Ala., is reported planning the construction of a plant addition.

Bids are being taken by the Wilmington Casting Co., Wilmington, O., for the erection of a pattern storage and bath rooms, 28 x 115 feet. Joseph Ross, care of the Champion Bridge Co., is architect. P. S. Horton is president and general manager of the company, instead of E. R. Bales, as was reported in the April 15 issue of The Foundry.

A plant built by the government at Buffalo for the Pierce-Arrow Motor Car Co., has been purchased by Levering Bros., 200 Key Highway, Baltimore, and will be devoted to the making of gray iron castings.

The Superior Foundry Co., East Seventy-first street, Cleveland, has obtained a permit to make general repairs and alterations to its plant. Contracts have been let.

NEW TRADE PUBLICATIONS

PIPE-THREADING MACHINERY:—An illustrated booklet of 48 pages, in which pipe-threading machinery is described and illustrated is being circulated by the Landis Machine Co., Waynesboro, Pa. The booklet describes in detail stationary pipe die heads, pipe threading and cutting machines, rotary pipe and nipple threading die heads, pipe and nipple threading machines and chaser grinders. Illustrations of these tools are given.

GAS PURIFICATION:—The Steere Engineering Co., Detroit, has prepared a 40-page illustrated bulletin containing a treatise on the method of gas purification. According to booklet, much of the data which it contains was collected from many of the papers which were read at meetings of various gas associations. The treatise is thorough, giving data as to material, preparation of gas, preparation of lime, purification with iron oxide, revivification of iron oxide and how air is used.

CONCENTRATING TABLES.—The Diester Concentrator Co., Ft. Wayne, Ind., has issued bulletins Nos. 2 and 3 describing its line of concentrating tables. A special diagonal deck coal washing table for use in removing ash and slag forming elements from pulverized fuel is described. Complete details regarding the installation of a plant to handle from 100 to 800 tons of coal per shift are presented. Bulletin No. 3 explains the theory and construction of the concentrators and illustrates the mechanical details.

INDUSTRIAL CARS.—The Biehl Iron Works, Inc., Reading, Pa., has prepared a complete catalog of its varied line of industrial cars and equipment. The types shown include dump, charging and platform cars for use on standard or special gage tracks, general purpose flat top trucks, cupola trucks and fire wagons. A few special cars are shown which are made up according to specifications. A car unloader which has been developed by the company is shown. This may be fastened to the side of a standard gondola or to a box car door, and filled by shoveling. The material then may be dumped directly into a wagon below. The company also manufactures various styles of buckets for handling bulk material. These are illustrated and described. Small furnaces, ladles and miscellaneous equipment occupy the last few pages of the catalog.

ASH DISPOSAL:—The reduction of costs in ash disposal systems, is the subject of a treatise given in an illustrated booklet of 12 pages, published by the American Steam Conveyor Corp., New York. The ash disposal system at the plant of the United Ice & Coal Co., Harrisburg, Pa., is described. The conveyor consists of a line of pipe into which ashes are fed and through which they are carried to a discharge point by current action. This current is created by a jet of high velocity steam discharged into the center of the pipe line in the direction the ashes are traveling. A vacuum is created behind the steam discharge, which in turn creates a current of air through an air intake in the line. The suction pulls the ashes through the system toward the steam unit fitting, where the steam is introduced and ejects the ashes through the discharge line of the installation. The illustrations show various installations.

MOLDING MACHINES.—The Berkshire Mfg. Co., Cleveland, has prepared a handsomely illustrated catalog of its line of molding machines. The details of operation of air squeezers, stripping plate machines, and the automatic molding machine which the company makes are fully explained and shown graphically from photographs. An automatic machine handling all the processes involved in making a mold is shown. The sand is riddled by a power revolving screen at the foot of an elevator conveyor. This automatically places the required amount of sand in the flask. The successive operations of ramming, vibrating, and drawing the mold from the pattern all are performed without further attention from the operator than to set the machine in motion. A universal jolt and plain squeezer mounted on a one-piece cast column, several types of vibrators, flasks and flask fittings complete the catalog.

POWDERED FUEL SYSTEM.—The Quigley Furnace Specialties Co., New York, has prepared a complete bulletin on its system of transporting, storing and firing powdered fuel. This takes up in detail the types of furnaces to which this fuel is adapted, and explains and illustrates the details of operation. The fundamental idea upon which this system is designed regards powdered fuel as a fluid, capable of flowing freely, and subject to control by valves. The preparation of fuel progresses regularly through several stages controlled by regulating devices which function automatically. Starting from the crusher to which coal is fed it is elevated to a magnetic separator where tramp iron is removed. It then passes to a crushed fuel bin, thence to a dryer, and by bucket elevator to the dried fuel bin. From this it is fed automatically to a pulverizer. A discharge pipe carries it then to a collector and through this to a pulverized fuel bin. From this point it is transported through pipes under air pressure to the mixer at the furnace. The system provides air pressure behind the fuel and forces it as water is forced by air pressure in a tank. A wide variety of installations are illustrated and described, and details of parts, dimensions, control features, and comparative costs of operation are presented.